FLORA ASSESSMENT

Groundrush, Supernova, and Kookaburra East

PROSPECT AREAS

Tenements Groundrush: EL28474,

Supernova: EL29595, EL25171, EL27590, EL29594, EL23932,

Kookaburra: East EL24177, EL23932, EL29594

Tanami Desert NT

Report prepared for
Northern Star Resources

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FRONTISPIECE: Images 1-4: Sandplain vegetation in the Tanami Desert Groundrush region

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PREFACE

All information on proposed operations contained in this document has been supplied by Northern Star Resources Ltd.

1 EXECUTIVE SUMMARY

Northern Star Resources Ltd propose to undertake exploration activities in three prospect areas (Groundrush, Supernova and Kookaburra East) within exploration tenements EL28474 (Groundrush); EL29595, EL25171, EL27590, EL29594, EL23932 (Supernova); and EL24177, EL23932, EL29594 (Kookaburra East) held by Tanami Gold in the north Tanami region.

Northern Star Resources Ltd (Northern Star) commissioned Low Ecological Services (LES) to provide a report detailing key flora species in the prospect areas, including photo identification and to provide training for staff to assist them to avoid threatened species. NSR specified that species should include all plants listed as conservation significant under the *Territory Parks and Wildlife Commission Act* (TWPCA), including data deficient (DD) and near-threatened (NT) species. As an alternative to on-ground surveying of the entire area within the three prospect areas, several representative locations were selected within each prospect area to assess the presence of significant plant species and assist NSR staff and Central Land Council North Tanami Rangers in identifying significant species. This report and accompanying photo-identification booklet provides the basis for future internal staff and North Tanami Ranger to undertake pre-clearance surveys of the respective exploration areas.

To understand the regional context for the targeted flora species, LES undertook a desktop assessment of the prospect areas and surrounding region to characterise the environment, identify habitats of significance and determine the likelihood of species presence. The desktop assessment is preceded by a long history of flora and fauna surveys in the Tanami by LES, and in the Granites-Dead Bullock Soak, Tanami Mine-Groundrush and Twin Bonanza areas particularly, since 1988. To identify historical and contemporary records of flora taxa of conservation significance in the region, we searched the NT Flora Atlas and Tanami Regional Biodiversity Monitoring (RBM) dataset within a 50 km area of the prospect areas. The *Environmental Protection and Biodiversity Conservation Act 1999* (the EPBC Act) Protected Matters Search Tool (PMST) also identified EPBC-listed species and habitats that may occur in the region. By combining these data sources, we could identify threatened flora species and other species of conservation concern, including weeds and introduced species that occurred, or have the potential to occur, in the three prospect areas.

Thirteen near-threatened flora species and 18 data deficient species were identified by the NT Flora Atlas as occurring within a 50 km radius of the Groundrush, Supernova and Kookaburra East prospect areas. One species of national conservation significance, the dwarf desert spike-rush (*Eleocharis papillosa*), vulnerable, was identified by the EPBC PMST however it is unlikely it will occur in the prospect areas based on habitat analysis. An additional five species of regional botanical significance classed as data deficient were also identified as potentially present. Of all these species, 11 were assessed as having a high likelihood of occurring within the three prospect areas due to their habitat requirements.

The desktop assessment was accompanied by a three day on-ground survey conducted from the 12th-14th February 2018. At each of the three prospect areas, four to five sites were chosen for detailed surveying, this included walking a 50 – 100 m vegetation transect. From the survey 111 species from 29 families were identified, including five species of conservation significance and 15 species of cultural significance to Warlpiri people. The survey was also utilised as a flora identification exercise for NSR staff and North Tanami Rangers.

It is recommended that the removal of mature trees be avoided, and no earthworks be undertaken under the canopy of the trees when undertaking drilling operations. The scattered trees within these sites are keystone structures that provide several ecological functions including; provision of a distinct microclimate, increased soil nutrients and plant species richness, increased structural complexity and habitat for animals (Manning, Fischer, & Lindenmayer, 2006). These tree species are also slow to regenerate after disturbances.

Significant species can be identified using The Flora Identification Booklet and then protected accordingly. Awareness of culturally significant species for Warlpiri people is suggested and efforts should be made to minimise impacts on the abundance of these species. While no introduced flora species were identified during the field survey, four weed species (ruby dock, kapok bush, buffel grass and *Chloris* sp.) are moderately likely to occur in the prospect areas if appropriate mitigation measures, such as vehicle washdown, are not taken to prevent their introduction.

These measures will ensure that any proposed development activities in the Groundrush, Supernova and Kookaburra East prospect areas are unlikely to have any significant impact on species of conservation and cultural significance in the region.

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1 INTRODUCTION

1.1 Overview

Low Ecological Services Pty Ltd (LES) were requested by Northern Star Resources Ltd (Northern Star) to assess and interpret flora data from the Groundrush, Supernova and Kookaburra East prospect areas to assist local staff to identify key flora species including conservation and culturally significant species.

1.2 Scope

The objectives of this flora assessment for the Groundrush, Supernova and Kookaburra East prospect areas were to:

- Identify and describe extant flora that may be affected by disturbance, including threatened species and other taxa of conservation significance;
- Interpret local data in a regional context through access to current spatial environmental datasets and databases, including the Tanami Regional Biodiversity Monitoring (RBM 2005–2012) dataset; and the NT flora atlas;
- Identify potential environmental impacts on environmental values, including important habitat areas and erosion potential, and assess the associated level of risk to these values;
- Conduct an on-ground flora survey at representative locations within the prospect sites with Northern Star staff and Central Land Council North Tanami Rangers to identify and provide familiarisation with key flora species with a view to training staff to avoid threatened species;
- Provide a report detailing key flora species and an accompanying flora identification booklet to aid future internal exploration pre-clearance surveys at the respective sites.

1.3 Legislative context

1.3.1 Commonwealth legislation

Environment Protection and Biodiversity Conservation Act 1999

The *Environmental Protection and Biodiversity Conservation Act 1999* (the EPBC Act) is the Australian Government's key piece of environmental legislation, which commenced on July 16, 2000. Two of the objectives of the EPBC Act are to provide for the protection of the environment, particularly matters of national environmental significance (MNES), and to conserve Australian biodiversity. Any referrals and environmental assessments should consider all MNES under the Act, in addition to matters of state and local significance. The EPBC Act identifies the nine MNES as:

- World heritage properties;
- National heritage places;
- Wetlands of international importance (Ramsar wetlands);
- Threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas;
- Great Barrier Reef Marine Park;
- Nuclear actions (including uranium mining); and
- Water resources, in relation to coal seam gas development and large coal mining development.

1.3.2 State legislation

Territory Parks and Wildlife Conservation Act

The Northern Territory (NT) *Territory Parks and Wildlife Conservation Act* (TPWC Act) is 'an Act to make provision for and in relation to the establishment of Territory Parks and other Parks and Reserves, and the study, protection, conservation and sustainable utilisation of wildlife'. Under the TPWC Act, all threatened species are classed as protected wildlife. The Act includes 'Principles of Management', which require that a threatened species be managed in a manner that 'maintains or increases their population or the extent of their distribution at or to a sustainable level'.

Environmental Assessment Act 1982 and Environmental Assessment Administrative Procedures 1984

The *Environmental Assessment Act* (EA Act) and the Environmental Assessment Administrative Procedures 1984 are administered by the NT Environmental Protection Agency. The EA Act provides a framework for the assessment of potential environmental impacts of developments. The object of the EA Act is to ensure that matters affecting the environment to a significant extent are fully considered in decisions by the NT Government. The assessment process also evaluates the effectiveness of the proposed safeguards to mitigate these impacts during construction and operational phases of the development.

Mining Management Act 2001

The *Mining Management Act 2001* (MM Act) is administered by the Department of Mines and Energy (DME). The objectives of the MM Act are to ensure that mining in the NT is conducted in accordance with best practice standards for health, safety and the environment. Under the MM Act, an application for authorisation to carry out mining activities must include a Mining Management Plan (MMP).

Weeds Management Act 2001

The *Weeds Management Act 2001* (WM Act) is administered by the NT Department of Environment and Natural Resources (DENR). The objective of the WM Act is to prevent the spread of weeds in, into and out of the NT and to ensure that the management of weeds is an integral component of land management in accordance with any other strategy adopted to control weeds in the NT.

1.3.3 Other legislation

Other legislation that may be applicable to prospecting activities:

General:

- *Mineral Titles Act 2016*
- *Northern Territory Environmental Protection Authority Act 2012*

Land Use:

- *Planning Act 2016*
- *Aboriginal Land Act 2013*
- *Crown Lands Act 2014*
- *Soil Conservation and Land Utilization Act 2016*
- *Bushfires Act 2014*
- *Pastoral Land Act 2016*

Cultural and Heritage:

- *Northern Territory Aboriginal Sacred Sites Act 2013*
- *Heritage Act 2016*

Water Quality and Biodiversity Conservation:

- *Water Act 2016*
- *Biological Control Act 2016*
- *Public and Environmental Health Act 2016*

Air Quality, Noise and Waste Management:

- *Waste Management and Pollution Control Act 2016*
- *Public and Environmental Health Act 2016*

Safety and Environmental Compliance:

- *Work Health and Safety (National Uniform Legislation) Act 2016*
- *Environmental Offences and Penalties Act 2011*
- *Transport of Dangerous Goods by Road and Rail (National Uniform Legislation) Act 2016*
- *Dangerous Goods Act 2012*

2 METHODS

2.1 Desktop review

Literature and database searches were undertaken to gain an understanding of the ecological context of the prospect areas. GIS mapping and a search of Australian Bureau of Meteorology (BoM) climate data provided an overview of the climate, soils, vegetation and habitats of the prospect areas and surrounds. Data collated from database searches provided information on the flora species known to occur in the region, particularly those of conservation significance. This data was validated through a review of the current literature.

2.1.1 Database review

A database review was undertaken using several data sources to provide an ecological context of the landscape, vegetation, habitats and climate of the prospect areas:

- Climate data online (Bureau of Meteorology, 2017);
- Interim Biogeographic Regionalisation of Australia (IBRA) (Thackway & Cresswell, 1995);
- Land Systems of the Alice Springs area, Northern Territory, Australia (Perry, Mahbbutt, Litchfield, & Quinlan, 1960);
- Digital Atlas of Australian Soils (Northcote, 1968);
- NTVIS - NT Data Compilation for the National Vegetation Information System to determine vegetation communities;
- Vegetation Survey of the Northern Territory Australia: Notes to accompany 1: 100, 000 Map Sheets (Wilson, Brocklehurst, Clark, & Dickinson, 1990);
- Geology, regolith mapping (Wilford & Butrovski, 1999);
- Fire history (North Australia and Rangelands Fire Information, 2017); and
- Aerial photographs and satellite imagery.

Species of conservation significance are those listed under the EPBC Act and/or TPWC Act. To determine which species of conservation significance occur, or are likely to occur, within the vicinity of the prospect areas, these main data sources were examined:

- The Commonwealth Government Department of the Environment and Energy (DoEE) Protected Matters Search Tool (PMST);
- NT Flora Atlas;
- NT sites of Conservation Significance (SoCS);
- Sites of Botanical Significance (SoBS); and
- Tanami Regional Biodiversity Monitoring (RBM) program.

The Commonwealth Government Department of the Environment and Energy (DoEE) Protected Matters Search Tool (PMST) identifies matters of national environmental significance under the EPBC Act that may occur in a specified area. The PMST is based on predicted distributions of EPBC-listed flora and fauna species and communities and/or their habitat, rather than known records. The PMST may predict the occurrence of a species or community in an area when there are no documented records from the area. The PMST was used to search a 50 km-radius around the prospect areas (Appendix 1). This wide radius was chosen due to low prior survey effort in the area and similar habitat throughout the radius area.

The NT Species Atlas is maintained by the Department of Environment and Natural Resources (DENR) and includes the NT Fauna Atlas, NT Flora Atlas, NT Sites of Conservation Significance (SoCS) and NT Sites of Botanical Significance (SoBS). The NT Fauna and Flora Atlas search provided a list of records of threatened, non-threatened and introduced fauna and flora species within a 50 km radius around the prospect areas, as well as Sites of Conservation Significance (SoCS) and Sites of Botanical Significance (SoBS) within the vicinity.

2.1.2 Literature review

A literature review provided information on the species occurring or potentially occurring within the prospect areas and surrounds. Information was collated to assess the potential for species of conservation significance to occur within the prospect areas and surrounds. Sources of literature reviewed include:

- Species Profile and Threats Database (Department of the Environment and Energy, 2017) for information about species listed in the EPBC Act – Information sheets, survey guidelines, recovery plans, and Threat Abatement Plans for Key Threatening Processes
- NT Threatened Species fact sheets published by the Department of Environment and Natural Resources (DENR)
- Scientific literature (various referenced sources)

2.1.3 Assessment of likelihood

To rank the likelihood of each identified species of conservation significance occurring within the prospect areas (low, moderate or high), habitats existing within the area, as mapped by geology, soil, land units and vegetation communities, were assessed for suitability for each species. We used information on species habitat requirements from the published literature, and habitats in which mapped records currently occur, to determine if the species' habitat is present or likely to be present within the prospect areas.

2.1 Field surveys

A three day on-ground survey was conducted on the 12th-14th February 2018. This survey was designed to gain a more detailed understanding of the area to be impacted by the proposed drilling as well as to survey for species of conservation significance. It was also a training workshop for Northern Star staff and the North Tanami Rangers, to learn flora survey techniques and recognise significant species. At each of the three prospect areas; Groundrush, Kookaburra East and Supernova, four to five sites were chosen for detailed surveying, where 50- 100 m vegetation transects were established (Figure 1).

These sites were chosen to incorporate the main habitat types in the area. Co-ordinates for the survey sites are provided in Appendix 1.

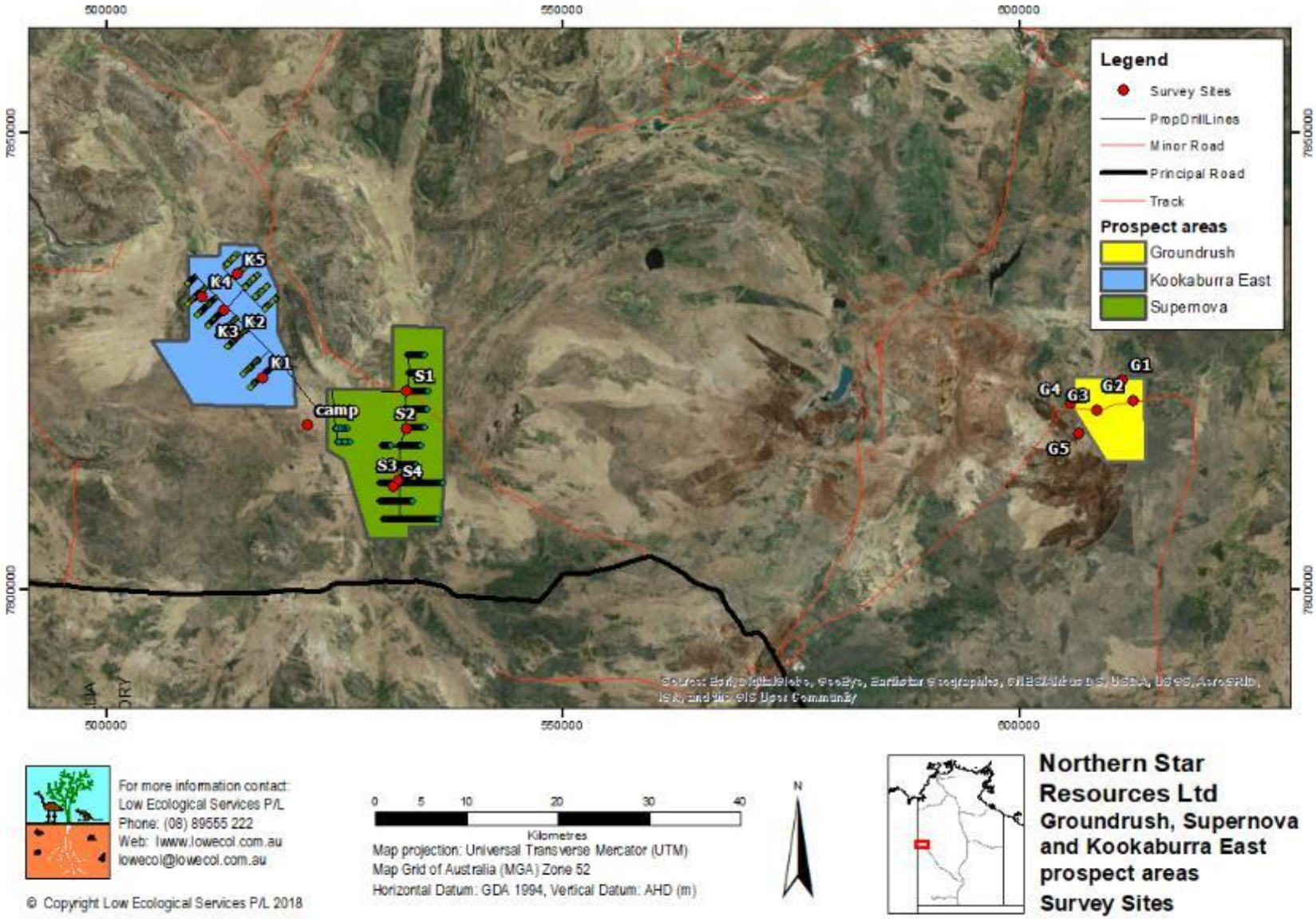

Figure 1. Survey site locations surveyed during on-ground survey 12-14th February 2018 at Groundrush, Kookaburra East and Supernova prospect areas, Tanami.

2.1.1 Landscape, vegetation and flora surveys

A site description was carried out within a 50 m × 50 m quadrat at each of the nine survey sites. Site descriptions provided an overall snapshot of the landscape, geology, soil, dominant flora species and vegetation structure and density at each site. The presence of termite mounds, woody debris, impact from disturbance, weeds and current vegetation condition were also noted. At each site photographs of the landscape and vegetation communities were taken from the north, south, east and west. This data has been summarised in identifying six different habitat types and their corresponding vegetation communities that exist within the prospect areas. GPS locations and extent of weed infestations were recorded. Where possible, GPS locations of large mature trees of cultural significance were taken.

A 50-100 m point-line transect was undertaken at each site to obtain a list of flora species and their percentage cover, as well as the percentage of other ground cover types (e.g. rocks, bare ground). Flora species lists were completed by doing a walkover of the area surrounding the transect to record additional species. Voucher specimens were taken where plants could not be identified in the field. Voucher specimens were identified by experienced botanist Des Nelson.

2.1.2 Skills Development

Northern Star staff and Central Land Council North Tanami Rangers were trained in conducting flora surveys. Specific skills developed included;

- Recognising and identifying plants using flora identification resources,
- Collecting and pressing plant specimens and taking photographs for later identification by botanists. This included labelling specimens by recording information of the GPS location, site description, identifying features of the specimen and date;
- Recording detailed site descriptions for each survey site; and
- Sharing knowledge of Indigenous culturally important flora and geological histories of the sites.

2.1.3 Limitations of the surveys

Records obtained from the NT Fauna and Flora Atlases display records only from areas which have been surveyed previously. The lack of records at a locality commonly represents a lack of survey effort as opposed to the absence of various species in the area.

LES has carried out surveys at an appropriate spatial scale for the proposed development. While this will increase the chances of obtaining sufficient data required to detect the presence of threatened species, it cannot be guaranteed that the species lists are complete.

Surveys were aimed at detecting appropriate landscapes and assessing the potential suitability of habitat and presence of threatened species within the survey areas. Population surveys for abundance and density were not conducted within the survey areas and surrounds.

3 EXISTING ENVIRONMENT

3.1 Climate

The Tanami region is semi-arid with a monsoonal influence. Rabbit Flat (Bureau of Meteorology station 015666) is the closest weather station to the Groundrush, Supernova and Kookaburra East prospect areas with consistent and current temperature data. Annual rainfall at Rabbit Flat is 483.7 mm, with a summer bias from November to March (DoE, 2015a). The mean minimum temperature at Rabbit Flat ranges from 6.8°C in July to 24.0°C in January (Bureau of Meteorology, 2017). The mean maximum temperature ranges from 25.7°C in June to 38.5°C in January (Bureau of Meteorology, 2017).

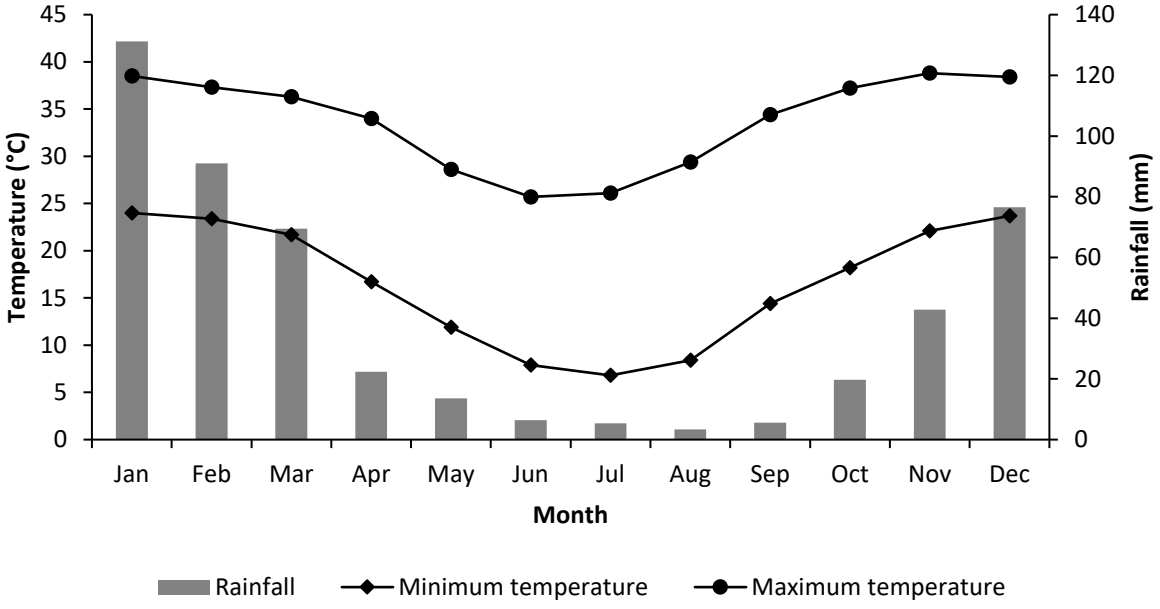

Figure 2. Monthly average rainfall and average minimum and maximum temperature at Rabbit Flat (Station 015666) [data 1996–2016] (Bureau of Meteorology, 2017).

3.2 Bioregion

The Interim Biogeographic Regionalisation of Australia (IBRA) is a classification system of geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information (Department of Sustainability, Environment, Water, Population and Communities, 2012). The Groundrush, Supernova and Kookaburra East prospect areas lie within the Tanami Desert subregion of the Tanami bioregion (Figure 3).

The Tanami bioregion is characterised by a complex mosaic of landforms and habitat and encompasses much of the extensive central Tanami Desert palaeodrainage system. Other habitats within the bioregion include alluvial plains, dunefields, sandplains, rocky hills and rises, freshwater and saline lakes, and claypans (Thackway & Cresswell, 1995). The diversity of habitats contributes to a rich flora and fauna diversity and the persistence of many threatened species. Vegetation is varied and includes *Triodia sp.* hummock grasslands with *Acacia* tall sparse-shrubland overstorey between dunes, snappy gum *Eucalyptus brevifolia* low open-woodland with soft spinifex understorey and *Eragrostis xerophila* open grassland with scattered trees and shrubs (White *et al.* 2000). Vegetation of wetland areas includes coolabah and bluebush at swamps and bare pans of ephemeral lakes containing *Ruppia* sp. fringed by *Melaleuca glomerata* or samphire and *Acacia maconochiana* fringing bare pans (Duguid, et al., 2005). Land tenure is primarily Aboriginal freehold, with 78.9% of the bioregion tenure held by five Aboriginal land trusts. The remaining tenures are held by pastoral leases (18.0%) and crown leases or vacant land (3.1%) (Baker, et al., 2005). The main land uses within the Groundrush, Supernova and Kookaburra East prospect areas are mineral exploration and Indigenous use.

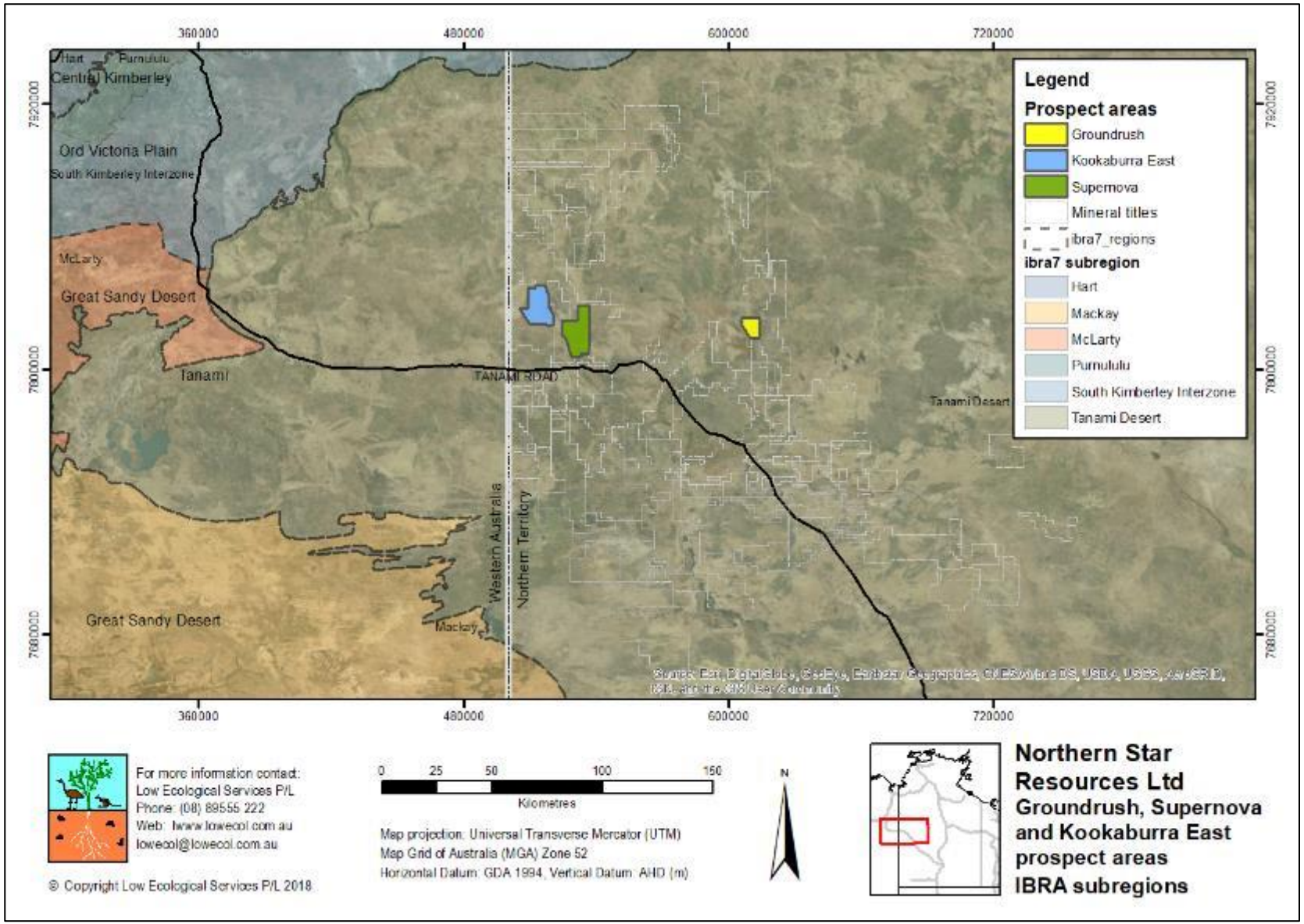

Figure 3. IBRA bioregions and IBRA subregions in relation to the Groundrush, Supernova and Kookaburra East prospect areas (Department of Sustainability, Environment, Water, Population and Communities, 2012).

3.3 Geology

The geological units of the Groundrush, Supernova and Kookaburra East prospect areas are described in Table 1 and mapped in Figure 4. The Groundrush, Supernova and Kookaburra East prospect areas consist of geological units N4, N5, N2, V6, -C1b and -C2 (Ahmad, 2000).

Table 1. Geological units present within and surrounding the Groundrush, Supernova and Kookaburra East prospect areas, as described by Ahmad (2000).

Map unit	Rock type	Description
b5	Igneous	Mafic volcanics
-C1b	Igneous	Flood basalt
g5	Igneous	Granite
-C2	Sedimentary	Limestone, shale
Cz	Sedimentary	Sand, clay, calcrete and lucastrine limestone in inland palaeodrainage
N2	Sedimentary	Amphibolite, schist, calc-silicate, dolerite
N4	Sedimentary	BIF, carbonaceous shale, mudstone, chert, amphibolite, schist, calc-silicate, dolerite
N5	Sedimentary	Sandstone
V6	Sedimentary	Sandstone, conglomerate, greywacke

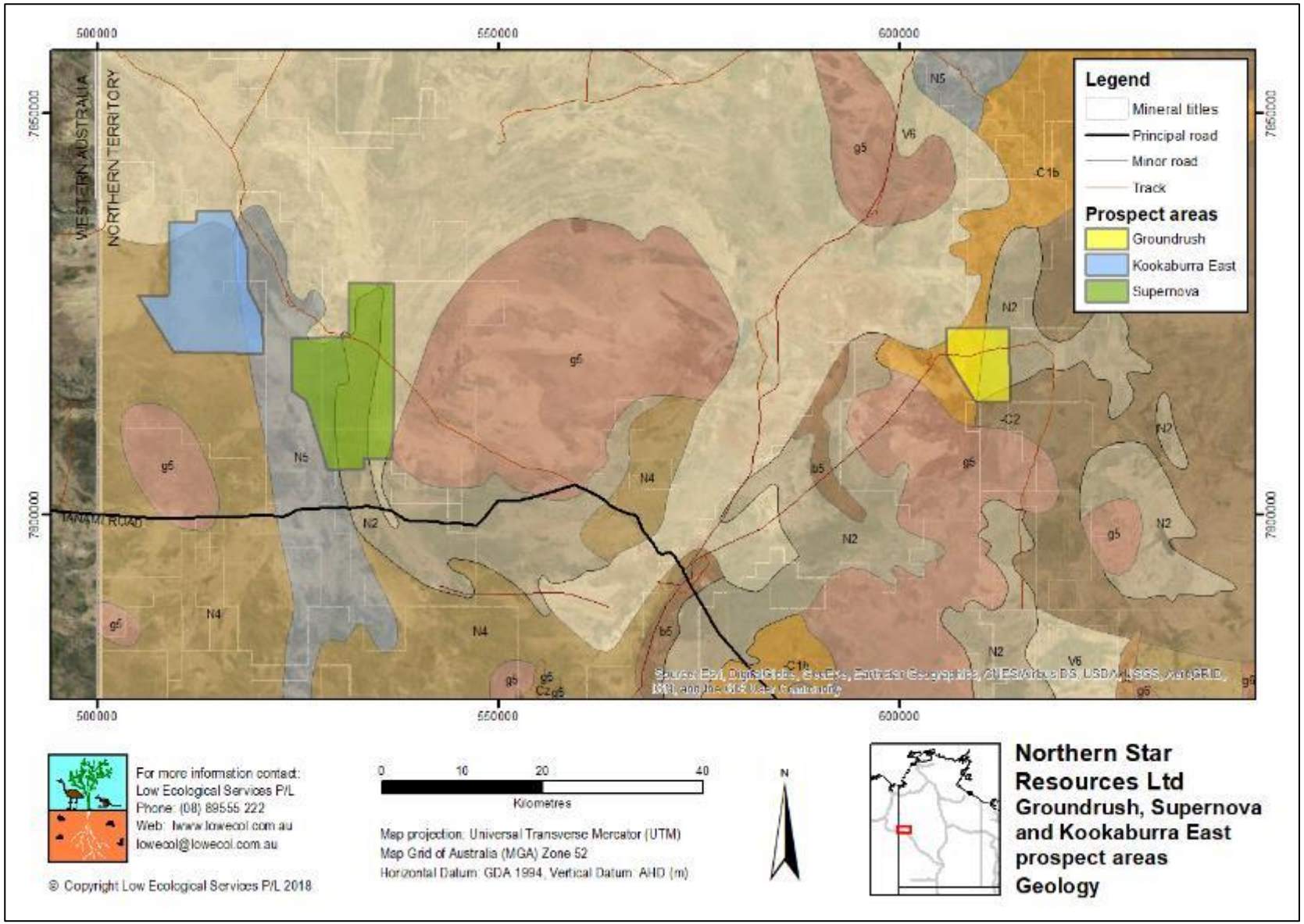

Figure 4. Geological mapping of the NT within and surrounding the Groundrush, Supernova and Kookaburra East prospect areas (Ahmad, 2000). Geological units are described in Table 1.

3.4 Soils

Soil types within the prospect areas have been mapped using the Atlas of Australian Soils (mapped by Bureau of Rural Sciences after Commonwealth Scientific and Industrial Research Organisation, 1991; described by Northcote (1968)). However, the currently accepted classification system is the Australian Soil Classification (ASC) (Isbell & National Committee on Soil and Terrain, 2016). A conversion from the Atlas of Australian Soils to the Australian Soil Classification was developed by Ashton and McKenzie (2001).

There are two mapped soil units within the Groundrush, Supernova and Kookaburra East prospect areas: AB29, a tenosol, and BA5, a rudosol. These soil units are described from both the Australian Soils Atlas and the Australian Soil Classification in Table 2, and mapped in relation to the prospect areas and immediate surrounds (Figure 5).

Table 2. Description of soil types within and surrounding the Groundrush, Supernova and Kookaburra East prospect areas from the Australian Soils Atlas (Northcote, 1968) and the Australian Soil Classification (Isbell & National Committee on Soil and Terrain, 2016), as converted by Ashton and McKenzie (2001).

Map unit	Australian Soil Atlas	Australian Soil Classification
AB29	Gently undulating plains: chief soils are red earthy sands with some yellow earthy sands on gently sloping plains and some siliceous sands in flood plain areas. Other soil occurrences include small areas of shallow ironstone-gravelly sands on low gravelly rises and very small areas of non-calcareous massive earth on broad shallow drainage floors.	**Tenosol:** Soils with generally only weak pedologic organisation apart from the A horizons. Encompasses a diverse range of soils that do not fit the requirements of any other soil orders and generally with one or more of the following: i. A peaty horizon. ii. A lumose, melacic or melanic horizon, or conspicuously bleached A2 horizon, which overlays a calcrete pan, hard unweathered rock or other hard materials; or partially weathered or decomposed rock or saprolite or unconsolidated mineral materials. iii. A horizons which meet all the conditions for a peaty, humose, melacic or melanic horizon except the depth requirement, and directly overlie a calcrete pan, hard unweathered rock or other hard materials; or partially weathered or decomposed rock or saprolite, or unconsolidated mineral materials. iv. A1 horizons which have a more than weak development of structure and directly overlie a calcrete pan, hard unweathered rock or other hard materials; or partially weathered or decomposed rock or saprolite, or unconsolidated mineral materials. v. An A2 horizon which overlies a calcrete pan, hard unweathered rock or other hard materials; or partially weathered or decomposed rock or saprolite, or unconsolidated mineral materials. vi. Either a tenic B horizon, or a B2 horizon with 15% clay (SL) or less, or a transitional horizon (C/B) occurring in fissures in the parent rock or saprolite which contains between 10 and 50% of B horizon material (including pedogenic carbonate). vii. A ferric or bauxitic horizon > 0.2 m thick. viii. A calcareous horizon > 0.2 m thick.

BA5	Stony hills and ranges largely derived from sandstones and having flanking sand plains: chief soils are pockets of shallow stony sands and sandy loams among the sandstone outcrops. Associated are small areas of red earthy sands on the gently sloping plains and valley floors.	**Rudosol:** Soil with negligible (rudimentary) pedologic organisation apart from (a) minimal development of an Al horizon or (b) the presence of less than 10% of B horizon material (including pedogenic carbonate) in fissures in the parent rock or saprolite. The soils are apedal or only weakly structured in the A1 horizon and show no pedological colour changes apart from the darkening of an A1 horizon. There is little or no texture or colour change with depth unless stratified or buried soils are present.

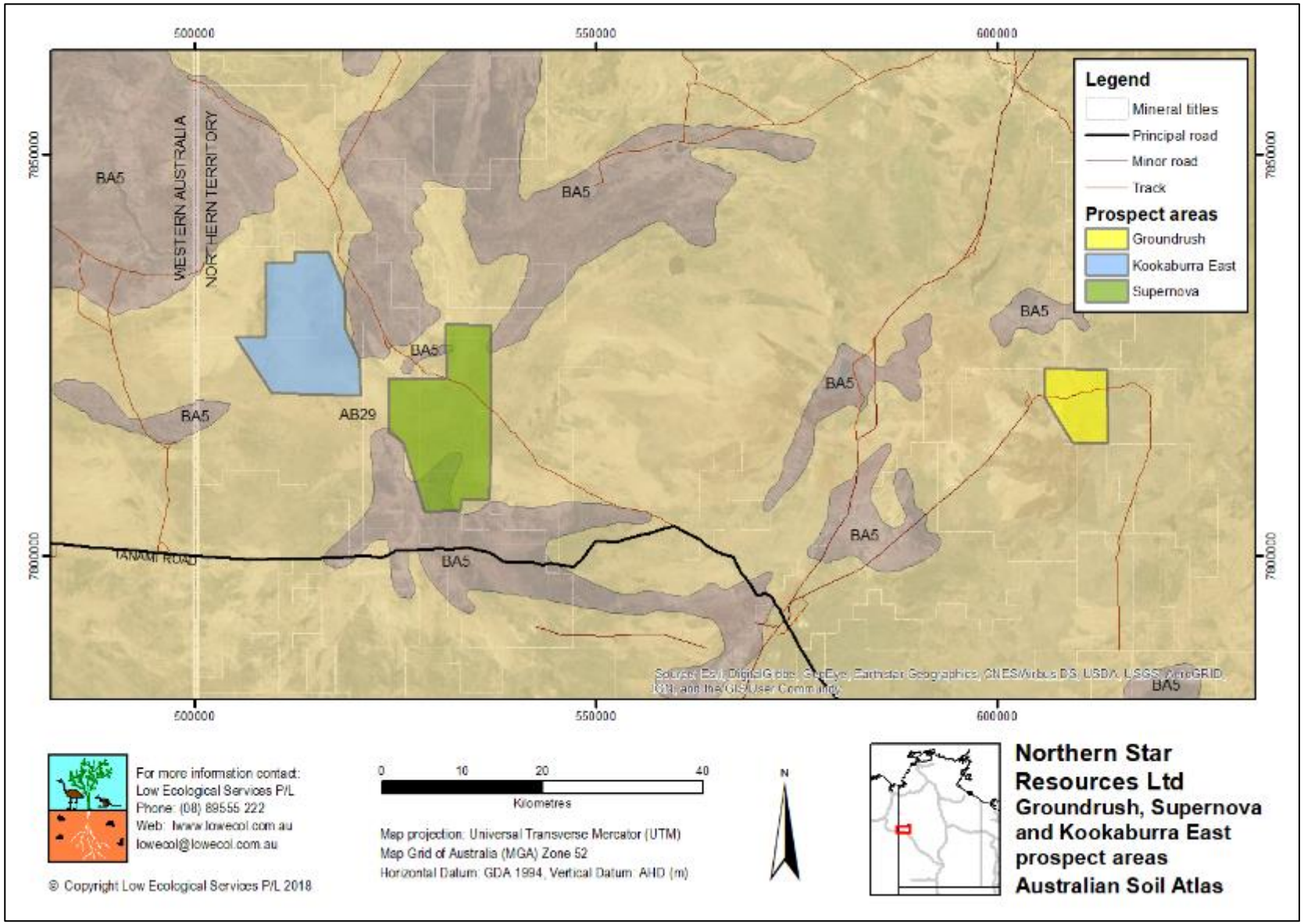

Figure 5. Soil units as mapped by the Atlas of Australian Soils (Bureau of Rural Sciences, 1991) within and surrounding the Groundrush, Supernova and Kookaburra East prospect areas. Soil units are described in Table 2.

3.5 Land units

Land units have long been used as classification units (Perry, Mahbbutt, Litchfield, & Quinlan, 1960), effectively representing patterns of different biological assemblages across the landscape (Oliver, et al., 2004). Existing land system mapping for the NT does not cover the area of interest within the Tanami, although some work has been done in isolated areas. These include Domahidy (1990) who characterised land units for his study of palaeodrainage channels in the central Tanami, and Low, Fowler and Nelson (1994) who provided more detail for the area around Tanami Well.

An alternative mapping system is based on regolith – soil mantle of material that overlies bedrock – derived from air photos. Mapping of regolith was undertaken for Newmont Pty Ltd in 1999 (Wilford & Butrovski, 1999). A total of 49 regolith units were mapped from Sangster's Bore in the south to approximately 140 km north of Tanami Mine, approximately 100 km east of Sangster's Bore, and west into Western Australia (WA) (Wilford & Butrovski, 1999).

Low *et al.* (2001) showed these regolith units could be re-interpreted in a systematic way to provide meaningful inferred land units or land systems (Foster & Low, 2004). An advantage of using regoliths to assign land units is that they are not affected by fire. Conversely land unit mapping based on vegetation can be confounded by different fire ages. Following Holmes and Low (2000), regoliths with similar geology, soils and landforms were grouped into similar land units resulting in the formation of seven land units over the study area (Low, Holmes, Vea, & Davies, 2001). The Groundrush, Supernova and Kookaburra East prospects are a mix of sheet flow deposits and highly weathered bedrock over alluvial sediments, over which wind-blown sands are redistributed as sand plains and shallow rises. (Table 3, Figure 5).

Table 3. Description of regolith land units within the Groundrush, Supernova and Kookaburra East prospect areas, mapped by Wilford and Butrovski (1999) and reinterpreted by Low *et al.* (2001).

Land Unit	Code	Regolith	Land form	Description
Palaeochannel	P	Transported regolith	Depositional plain	Alluvial, colluvial and lacustrine sediments consisting of sand, silt and clay of varying thickness forming extensive low relief depositional plains and playa lakes. Alluvium mainly covered by sheetflow and Aeolian ferruginous fine to medium quartzose sand. Calcrete common.
Elevated drainage depression	EED	In situ regolith	Depositional plain	Sheetflow and minor alluvial deposits consisting of ferruginous fine to coarse quartzose sand and sandy clay. Aeolian sands reworked by sheetflow processes. Quartz, lithic, ferruginous gravel/granular lags. Residual quartzose sand. Micaceous sand locally common.
Shallow sandplain	SSP	Transported regolith	Pediment	Colluvial fan and sheetflow deposits consisting of medium to fine ferruginous quartzose sand, minor ferruginous lithic fragments, quartz and iron (Fe) nodules. Forms low angle colluvial fans and pediments.
Loamy sandplain	LmSP	In situ/Transported regolith	Depositional plain	Sheetflow and local alluvial deposits consisting of ferruginous fine to coarse quartzose sand and minor gravel. Local dunes and sand spreads. Aeolian sands reworked by sheetflow processes. Colluvial and alluvial sands of varying thickness. Local patchy quartz, lithic and Fe nodule/granulelags.
Lateritic sandplain	LtSP	In situ regolith	Depositional plain	Sheetflow deposits consisting of Fe nodules and granules over medium to fine ferrugionous quartzose sand. Reworked Aeolian sand and local alluvial sediments. Residual sands and clay. Highly weathered ferruginous saprolite or Fe duricrust likely to be within 2m of the surface. Lags consist of Fe nodules and granules and minor quartz.
Chert rise	CR	In situ regolith	Rises	Saprolite partly covered by gravel lags, residual clays and ferruginous sands. Minor alluvial sediments. Lags consist of lithic fragments, Fe gravel and quartz. In places mottled and bleached saprolite exposed at surface. Soils and colluvium likely to be locally derived.
Lateritic rise	LR	In situ regolith	Depositional plain	Thin cover of sheet flow ferruginous sand, Fe nodules and gravel over Fe duricrust or saprolite. Saprolite typically highly ferruginous and mottled at depth. In places lithic fragments and Fe nodules are cemented to form Fe duricrust. Ferruginous lithic and lags. Minor quartz lag.

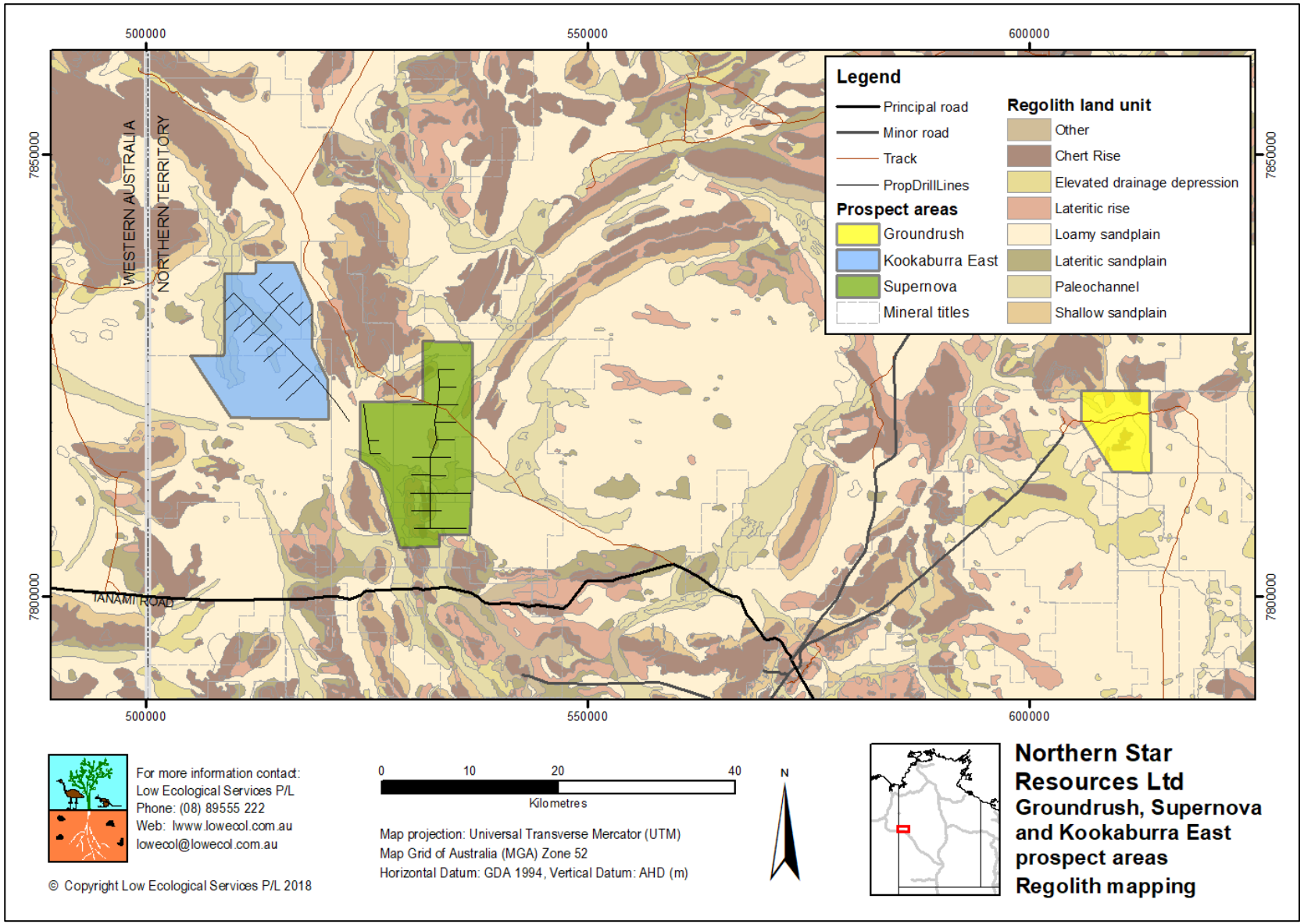

Figure 6. Land units derived from regoliths around the Groundrush, Supernova and Kookaburra East prospect areas, mapped by Wilford and Butrovski (1999) and reinterpreted by Low *et al.* (2001). See Table 3 for descriptions of each land unit.

3.6 Vegetation types

Vegetation types around the project areas have been mapped at a scale of 1: 1,000, 000 in the Vegetation Survey of the Northern Territory (Wilson, Brocklehurst, Clark, & Dickinson, 1990). This initial mapping was revised in 2007 and compiled into the National Vegetation Information System (NVIS), version 3.1.

Vegetation map units of the Groundrush, Supernova and Kookaburra East prospect region are shown in Figure 7 and described in Table 4. One vegetation NVIS map unit (76) dominates the prospect areas: low open hummock grassland occurring on red siliceous sandy soils (Table 4, Figure 6). However, NVIS map unit 38, open *Eucalyptus* woodland on well-drained rises, also intersects the north-west corner of the Groundrush prospect area (Figure 6).

Table 4: Description of vegetation types within and surrounding the Groundrush, Supernova and Kookaburra East prospect areas, as mapped by Wilson *et al.* (1990) and revised in the National Vegetation Information System (NVIS) 2007.

Vegetation map unit NVIS (Wilson *et al* 1990)	Broad vegetation classification	Structural formation	Environmental description	Vegetation strata
76	Low isolated *Eucalyptus* trees and tall sparse *Acacia* shrubland over *Triodia* low open hummock grassland	Open hummock grassland	Red siliceous sandy soils	Upper stratum: *Eucalyptus pruinosa, Corymbia opaca* Mid stratum: *Acacia stipuligera, Grevillea wickhamii* Ground stratum: *Triodia pungens, Triodia schinzii*
38	Low open *Eucalyptus* woodland and mid sparse *Acacia* shrubland over *Triodia* mid hummock grassland	Open woodland	Well drained rises, dissected pateaux and rocky low hills. Gravelly loams and sandy red earths.	Upper stratum: *Eucalyptus brevifolia, Corymbia dichromophloia* Mid stratum: *Grevillea parallela, Acacia lysiploia* Ground stratum: *Triodia pungens, Aristida holathera*
52	*Acacia* low open woodland and *Melaleuca* mid open shrubland over *Triodia* low hummock grassland	Woodland	Depressions, periodically flooded claypans or playas	Upper stratum: *Acacia kempeana*, *Grevillea juncifolia* Mid stratum: *Melaleuca glomerata*, *Eucalyptus microtheca* Ground stratum: *Triodia* pungens, Triodia *schinzii*, *Eragrostis falcata*

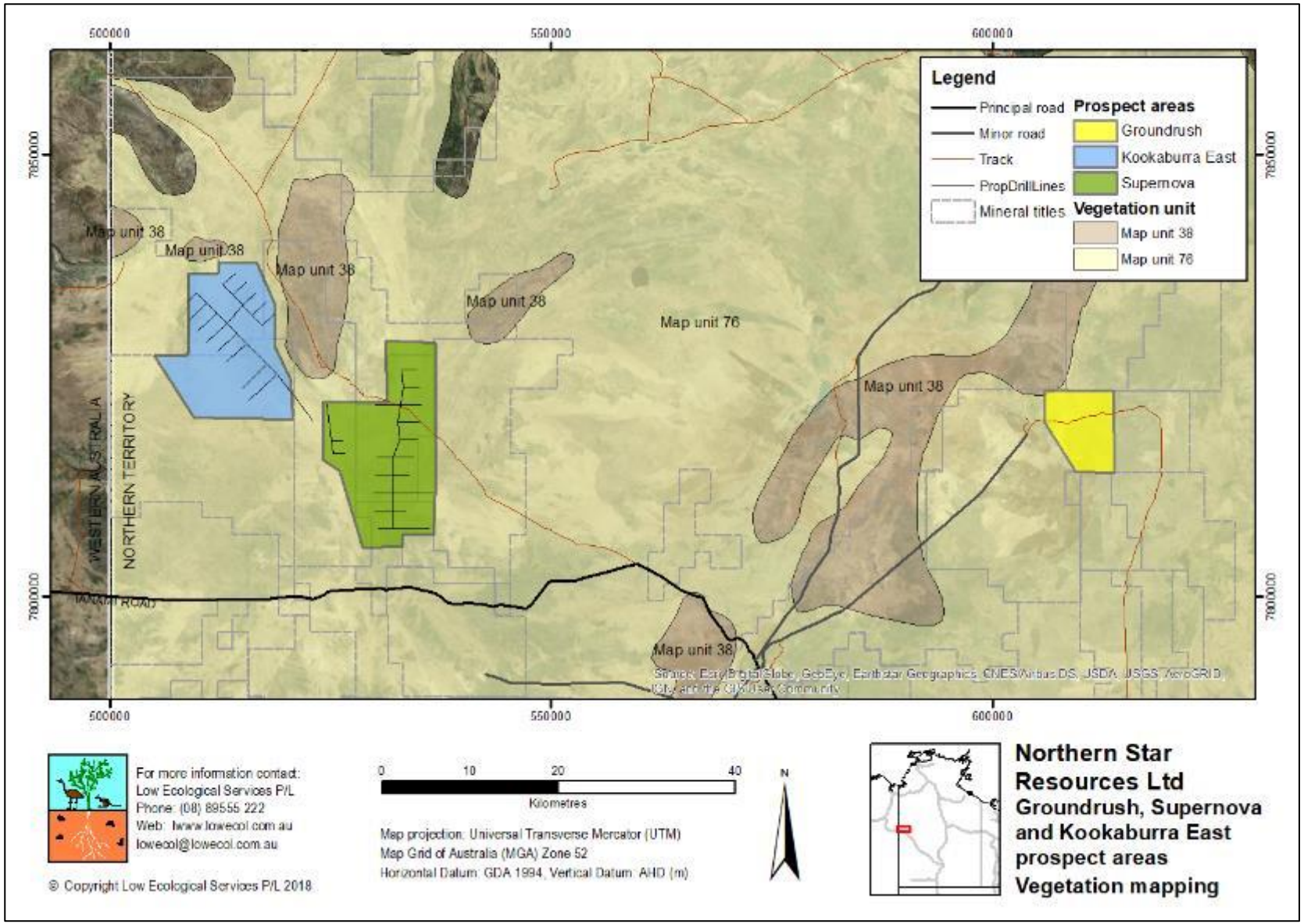

Figure 7. Vegetation map units within and surrounding the Groundrush, Supernova and Kookaburra East prospect areas (Wilson, Brocklehurst, Clark, & Dickinson, 1990). Vegetation units are described in Table 4.

3.7 Sites of Conservation Significance

Sites of Conservation Significance (SoCS) are identified as important sites for biodiversity that need further protecting; in the NT there are 67 SoCS. The 67 areas include sites both of national and of international significance. The prospect areas and surrounds are located to the north of the International Site of Conservation Significance (ISoCS), 43: South-west Tanami Desert (Figure 8).

Sites of Botanical Significance (SoBS) are defined as areas that have botanical features distinguishing them from the surrounding landscape, and that are important in terms of the presence of significant plant communities, the presence of species type localities, the integrity of the ecosystems present and the diversity of plant taxa and plant communities present (White, Albrecht, Duguid, Latz, & Hamilton, 2000).

The Gardiner Range SoBS overlaps the western boundary of the Kookaburra East prospect area, and the Pargee SoBS overlaps a portion of both the Kookaburra East and Supernova prospect areas (Figure 8). These sites are of bioregional significance. The Coomarie SoBS and northern part of the Tanami Range SoCS are located between the Supernova and Groundrush prospect areas. The landscape incorporates several of the large palaeodrainage features of the central desert, which contain many rare and poorly known plant taxa including taxa of Australian, NT and bioregional significance.

Both the Gardiner Range and Pargee SoBS contain 19 taxa of NT Significance (see Table 5) and host one species of Australian significance; *Corymbia pachycarpa* subsp*. glabrescens* (White, Albrecht, Duguid, Latz, & Hamilton, 2000).

The Gardiner Range SoBS includes to the south the Pingidijarra Hills and surrounding floodout woodlands dominated by *Corymbia flavescens* and adjacent open hummock grasslands. The Pargee SoBS is characterised by low outcropped sandstone (less than 100 m above the surrounding sandplain), which forms the Pargee Range. Botanical values at this site are concentrated around rockholes and waterholes in the ranges (White, Albrecht, Duguid, Latz, & Hamilton, 2000).

Table 5. Taxa of NT bioregional significance within Sites of Botanical Significance (SoBS) near the Groundrush, Supernova and Kookaburra East prospect areas as described by (White, Albrecht, Duguid, Latz, & Hamilton, 2000). NT: near threatened, LC: Least Concern, DD: data deficient.

Sites of Botanical Significance	Scientific Name (NT Conservation Status)	NT Conservation Status (TPWCA)
Gardiner Range	*Acacia stipulosa*	NT
	Buchnera asperata	LC
	Centipeda racemose	LC
	Corchorus pumilio	LC
	Cullen corallum	DD
	Dicrastylis doranii	DD
	Eucalyptus cupularis	NT
	Gomphrena leptophylla	LC
	Indigofera ammobia	DD
	Jacksonia aculeate	DD
	Pluchea tetranthera	LC
	Polymeria A93357 Western Tanami	DD

	Senna curvistyla	LC
	Trianthema oxycalyptra var. *oxycalyptra*	DD
	Triodia latzii	LC
	Triumfetta clivorum subsp. *brevipetala*	DD
	Triumfetta johnstonii	LC
Pargee	*Cyperus viscidulus*	DD
	Eucalyptus cupularis	NT

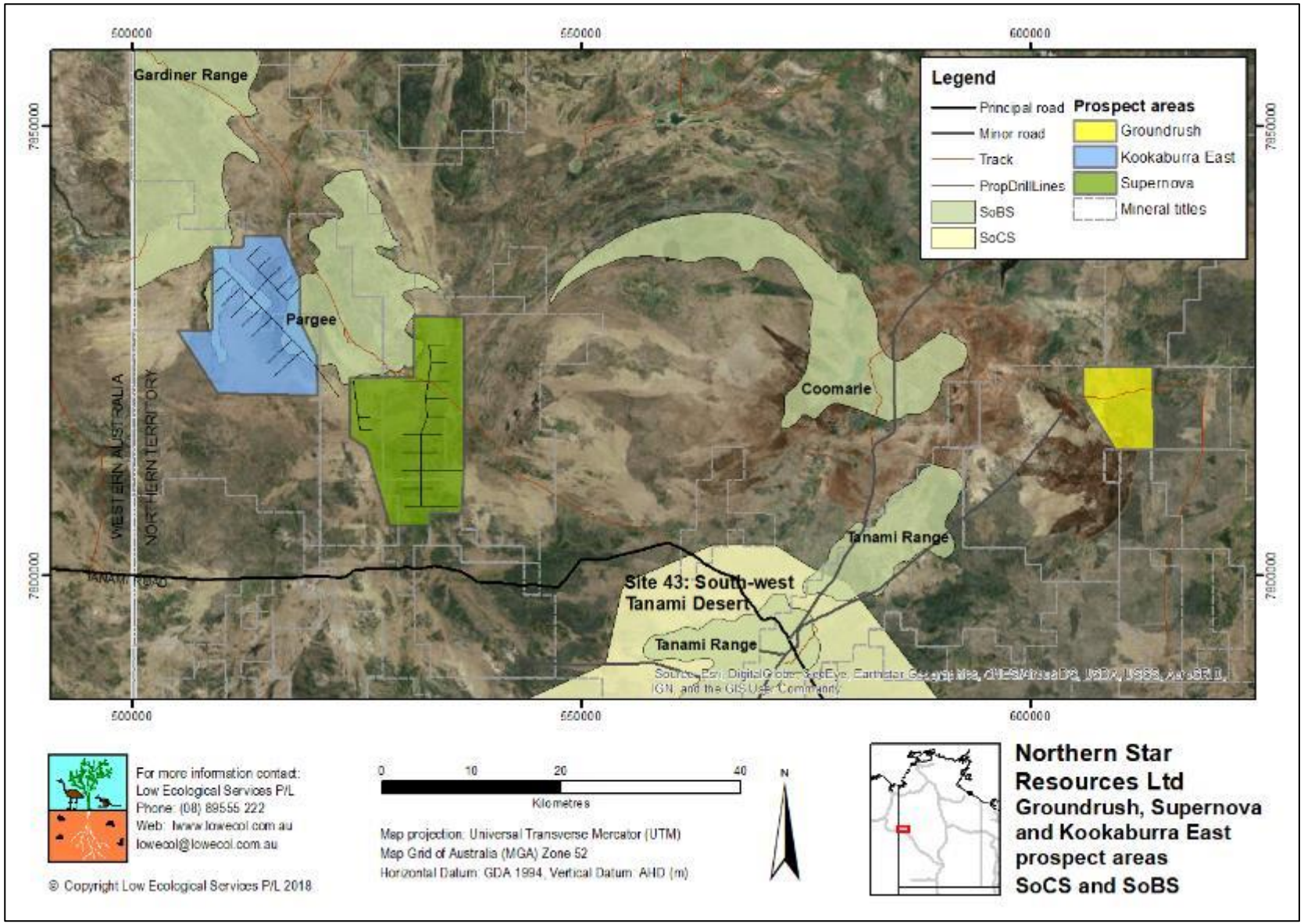

Figure 8. Sites of Conservation Significance (SoCS) and Sites of Botanical Significance (SoBS) within the area surrounding the Groundrush, Supernova and Kookaburra East prospect areas.

3.8 Fire history

Fire history mapping by the North Australia Fire Information (NAFI) service (North Australia and Rangelands Fire Information, 2017) shows that extensive fires in 2011, 2015 and 2017 burnt large proportions of the Groundrush, Supernova and Kookaburra East prospect areas and surrounds. Most of the Kookaburra East and Supernova prospects were burnt in 2011 and in 2015. Most of the Groundrush prospect area was burnt in 2011 and 2014, and again in September 2017 (Figure 9).

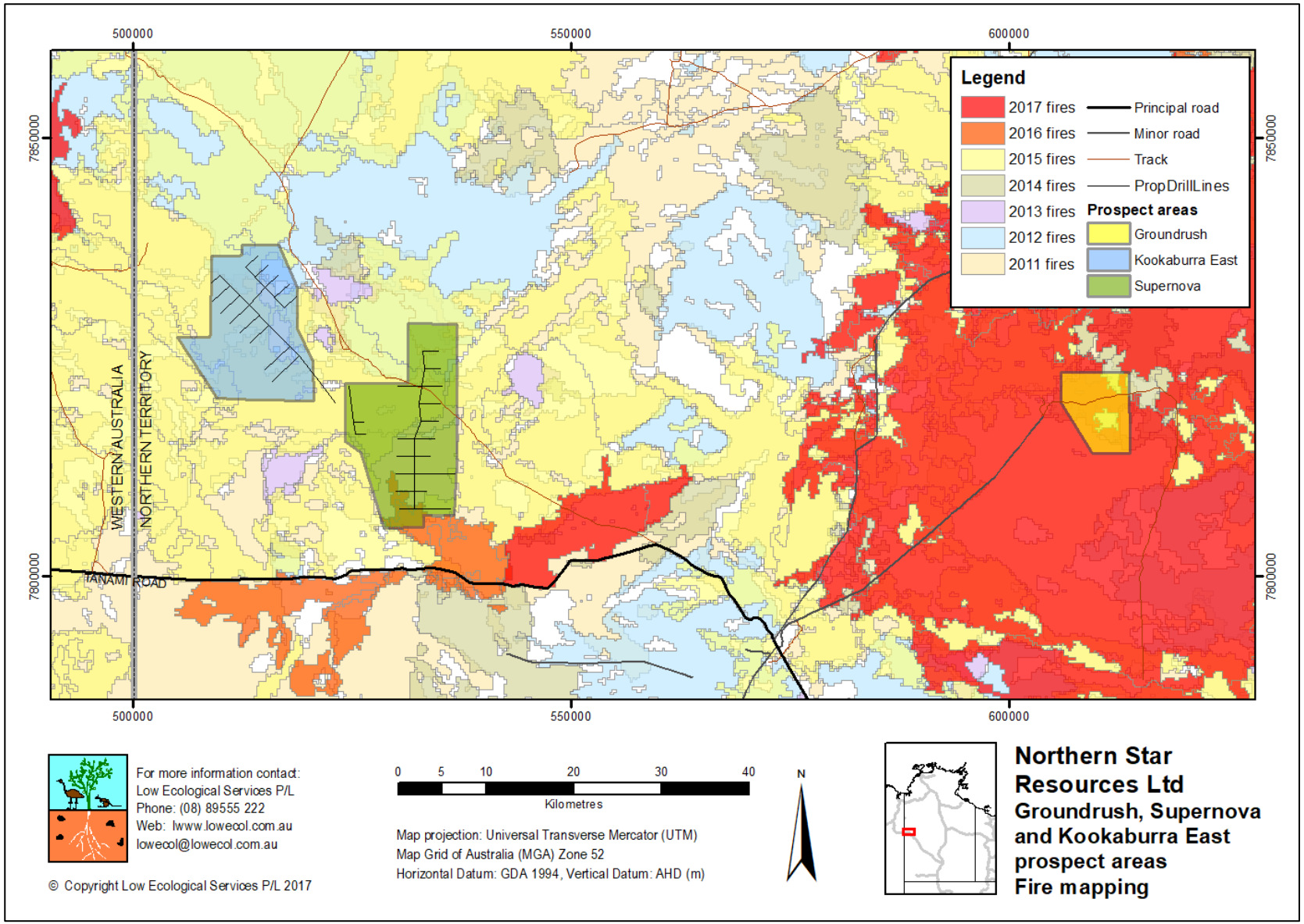

Figure 9. Fire history 2011–Oct 2017 within and surrounding the Groundrush, Supernova and Kookaburra East prospect areas (North Australia and Rangelands Fire Information, 2017).

3.9 Flora

3.9.1 Flora records

The NT Flora Atlas identified 2293 records of 639 flora species within 50 km of the prospect areas.

3.9.2 Flora species of conservation significance

Of these 639 flora species, 32 species are listed as species of conservation significance: thirteen near threatened sub/species, 18 data deficient species, and one threatened species, the dwarf desert spike-rush (*Eleocharis papillosa*) (Table 6, Figure 9). *Eleocharis papillosa* is listed as vulnerable under both the TPWC Act and nationally under the EPBC Act. One record of *E. papillosa* was reported in the NT Flora approximately 48 km south of the Groundrush prospect area from 1980 (Figure 9). Five species of regional botanical significance, listed as data deficient, that also occur within 50 km of the prospect areas have been included in Table 5 below (White, Albrecht, Duguid, Latz, & Hamilton, 2000). The EPBC Protected Matters search tool did not identify any threatened flora species within the 50 km radius areas (see Appendix 2).

Given the open hummock grassland habitats of the three prospect areas (see Section 3.6), it is unlikely that five of the conservation significant taxa (*Eleocharis papillosa*, *Tecticornia halocnemoides* subsp. *tenuis*, *Marsilea latzii*, *Ruppia tuberosa and Peplidium* sp. Tanami) will occur within them. These five species are associated with low-lying swampy areas and are more likely to be detected within paleodrainage habitats (Table 6).

3.9.3 Threatened Ecological Communities

No threatened ecological communities were identified within this desktop search within 50 km of the Groundrush, Supernova and Kookaburra East prospect areas.

Table 6. Flora species of conservation significance identified by the NT Flora Atlas as occurring within 50 km of the Groundrush, Supernova and Kookaburra East prospect areas. Five additional data deficient species of regional botanical significance are included as identified by White et al. (2000). Species are ranked on their likelihood of occurring within the prospect areas based on habitat. VU: vulnerable, NT: near threatened, DD: data deficient.

Family	Scientific name	Status		Habit	Description	Habitat	Likelihood of occurrence
		TPWC	EPBC				
FABACEAE	*Acacia abbreviata*	NT	-	Shrub	Spreading, resinous shrub 0.3-0.6m high. Bark minutely fissured, pale greyish brown. Phyllodes linear, narrowly oblong or very narrowly oblanceolate. Inflorescences - Spikes 0.7-1.5cm long, golden.	Grows in shallow red clay loam on stony lateritic plains and ridges with Spinifex, particularly in disturbed areas	High
FABACEAE	*Acacia maconochieana*	DD	-	Tree	Tree growing up to 12m high. Bark longitudinally fissured, grey. Phyllodes linear, 8-18cm long, 2-5mm wide, densely silvery white. Inflorescences 2-4 headed racemes, heads globular, 5mm diameter, hairs pale yellow ageing white.	Grows mainly in loam and clay depressions, some of which are periodically waterlogged, in open scrub, low open forest and woodland. Occurs commonly around black soil lakes and water courses in southern VRD north of Tanami Gold holdings.	Low/ Moderate
FABACEAE	*Acacia pachycarpa*	DD	-	Shrubby tree	Weeping shrubby tree 3-6m high. Phyllodes broadly linear to very narrowly elliptic, 13-34cm long, 6-20mm wide. Inflorescences - spikes 3-6cm long, cream.	Grows commonly along drainage lines in clay depressions and clay pans but also in sandy alluvium along creeks and in sandy loam. Often forms single species communities. Occurs at Lake Lima in south Tanami Gold holdings.	Moderate
FABACEAE	*Acacia stellaticeps*	DD	-	Shrub	Rounded or flat-topped, glabrous, resinous shrub to 2m high. Bark smooth, grey or dark grey. Phyllodes elliptic-obovate, slightly curved to straight 0.8 - 2.5cm long, 4-10mm wide. Flowers Feb - Sept: globular.	Grows in red, sometimes clayey sand over quartzite, limestone, laterite or ironstone, on hills or sandplains, often on flats between parallel sand dunes, in open savannah, scrub heath, grassland or shrubland, often with spinifex.	High

Family	Scientific name	Status		Habit	Description	Habitat	Likelihood of occurrence
		TPWC	EPBC				
FABACEAE	*Acacia stipulosa*	NT	-	Shrub	Prickly shrub to 3m high. Phyllodes crowded, broadly elliptical or triangular 4-8mm long, 2--5mm wide. Inflorescences - globular heads, golden.	Grows in shallow soil on sandstone, in shrubland and woodland.	Moderate
FABACEAE	*Acacia synchronicia*	DD	-	Shrub or tree	Somewhat diffuse, glabrous shrub or tree 1.5-3m high, sometimes 6m. Phyllodes variable, narrowly oblong to narrowly elliptical, usually 10-30mm long and 3-8mm wide. Inflorescences - heads globular.	Grows along watercourses and on alluvial flats, mostly in shrubland.	Low
POACEAE	*Acrachne racemosa*	DD	-	Grass	Annual, grass-like or herb, 0.2-0.4m high.	Occurs in brown, sandy loam over loamy clay on coastal flats in associated with low, deciduous vine thickets	Low
AMARANTHACEAE	*Amaranthus induratus*	DD	-	Herb	Information unavailable.	Information unavailable.	Low
POACEAE	*Brachyachne prostrata*	NT	-	Grass	Annual grass readily recognized by its prostrate habit, pseudo stolons and short often enclosed spikes. Flowering April to July	Red sand, sandy loam or clay	High
BYBLIDACEAE	*Byblis rorida*	DD	-	Herb	Erect or leaning annual herb, 0.06-0.3m high. Flowers purple Jan to May.	Occurs in red or yellow sand, clayey sand, lateritic or rocky soil. Creek banks, sandstone outcrops, woodland.	High
CLEOMACEAE	*Cleome uncifera*	NT	-	Herb /shrub	Viscid perennial, herb or shrub, 0.15-1.6m high. Flowers yellow	Grows in sandy and clayey soils. Sandplains, dunes, granite outcrops.	High

Family	Scientific name	Status		Habit	Description	Habitat	Likelihood of occurrence
		TPWC	EPBC				
CLEOMACEAE	*Cleome uncifera* subsp. *microphylla*	NT	-	Shrub	Low spreading, densely-branched shrub to 0.5m high. Flowers yellow, May to Nov	Sand Dunes and sandy soils.	Moderate
MYRTACEAE	*Corymbia pachycarpa* subsp. *glabrescens*	DD	-	Tree	A stunted tree or mallee up to 6 m tall with thick rough, fibrous, tessellated or fissured bark, young branchlets rough to touch, a crown of sessile opposite juvenile leaves that may feel rough or ± smooth, long-beaked buds that bear long or short bristles (setae), and thick-walled fruit.	It occurs on stony red loams or red sands	High
FABACEAE	*Cullen corallum*	DD	-	Shrub	Erect shrub, to 2 m high. Fl. yellow & green & cream/white, Aug to Sep.	Red pindan soils	Moderate
CYPERACEAE	*Cyperus viscidulus*	DD	-	Sedge	Shortly rhizomatous, tufted perennial, grass-like or herb (sedge), 0.3-0.15m high. Flowers yellow-brown, Feb to August. Separated from other Cyperus species, having triangular black nuts being visible through translucent glumes.	Alluvial or yellow-grey sand, sandstone, Along watercourses, waterholes.	Low/ Moderate
LAMIACEAE	*Dicrastylis doranii*	DD	-	Shrub	Spreading shrub, 0.2-1(-1.5) m high. Flowers are white and flowering Jul to Dec or Jan.	Yellow or red sand. Sand dunes, chenopod flats, sandplains.	Moderate
POACEAE	*Ectrosia schultzii* var. *schultzii*	DD	-	Grass	Densely caespitose perennial, grass like or herb, 0.25-0.7m high. Flowers purple Jan - August.	White, grey or red sand. Swamps, seepage areas. Dominant in depressions and creek lines on deep sandy soil; less common in heavier soils near creeks.	Moderate

Family	Scientific name	Status		Habit	Description	Habitat	Likelihood of occurrence
		TPWC	EPBC				
ELATINACEAE	*Elatine macrocalyx*	NT	-	Herb	Prostrate annual glabrous herb forming small dense mats. Flowers: May-Oct, flowers are white sometimes with green tinge.	On temporarily moist margins of playa lakes and clay pans. Soils are typically shallow sands over clay.	Low
CYPERACEAE	*Eleocharis papillosa*	VU	VU	Sedge	Perennial grass-like sedge, 0.07-0.6m high. Flowers green/purple	Seasonally wet areas such as claypans, soaks, depressions, the banks of gravelly beds of creeks, the margins of swamps and waterholes, streamlines, calcrete flats and soils of sandy clays and loams.	Low
POACEAE	*Eriachne flaccida*	NT	-	Grass	Perennial grass-like or herb, 0.07-0.6m high. Flowers green/purple	Seasonally wet areas such as claypans, soaks, depressions, the banks of gravelly beds of creeks, the margins of swamps and waterholes, streamlines, calcrete flats and soils of sandy clays and loams.	Low/ Moderate
MYRTACEAE	*Eucalyptus cupularis*	NT	-	Tree	Small tree to 8m tall. Characterised by smooth white powdery bark, glaucous branchlets, distinctly petiolate, concholorous, dull green, lanceolate adult leaves and the large glaucous buds and fruit.	Grows in foothills of low hills or on seasonally flooded, low lying areas or along drainage lines or watercourses.	Moderate
MOLLUGINACEAE	*Glinus orygioides*	NT	-	Herb/ shrub	Perennial to 0.3m, flowers pink in June.	Claypans	Low
BORAGINACEAE	*Heliotropium parviantrum*	DD	-	Herb	Erect annual herb to 0.15m high. Flowers Feb to June	Sandy soils. Flats, plains, rocky slopes	High
BORAGINACEAE	*Heliotropium sphaericum*	DD	-	Herb	Annual herb to 0.2m high. Flowers May	Red soils	High

Family	Scientific name	Status		Habit	Description	Habitat	Likelihood of occurrence
		TPWC	EPBC				
FABACEAE	*Indigofera ammobia*	DD	-	Shrub	Many-stemmed shrub, to 0.5 m high. Flowers are green & purple and flowering in Sep.	Red sand. Sand dunes.	Moderate
ASTERACEAE	*Iotasperma sessilifolium*	DD	-	Herb	Erect herb. Flowers pink.	Cracking clay, black loam. Edges of waterholes, plains	Low
FABACEAE	*Jacksonia aculeata*	DD	-	Shrub	Divaricate, somewhat spiny shrub, 0.2-1m high. Flowers yellow/yellow orange April to October	Red sand. Sand dunes and sandplains.	High
MARSILEACEAE	*Marsilea latzii*	NT	-	Herb	Four-leafed water clover-like plant with 4 leaflets, arranged symmetrically crosswise at the apex of a stipe, floating in submerged plants. Leaflets cuneate, 1-6 mm long, 1-4 mm wide.	Grows in sand on the margins of brackish lakes.	Low
LAMIACEAE	*Newcastelia cladotricha*	DD	-	Shrub	Grows to 0.3-0.8(-1.5) m high with blue-purple/white flowers. Flowering from Apr – Nov and baring fruit from Jun – Sep.	Red sandy soils. Sandplains, sand dunes.	Low/ Moderate
PHRYMACEAE	*Peplidium* sp. *Tanami*	DD	-	Herb	Fleshy prostrate growing herb with fleshy leaves.	Claypans, ephemeral pools	Low
CONVOLVULACEAE	*Polymeria* A93357 Western Tanami	DD	-	-	Little information available. Possibly a form of *Polymeria distigma*	Information unavailable.	Low
RUPPIACEAE	*Ruppia tuberosa*	NT	-	Herb	Submerged herb found in shallow hypersaline waters. Annual or delicate short-lived perennial with slender rhizomes.	Salt pans	Low

Family	Scientific name	Status		Habit	Description	Habitat	Likelihood of occurrence
		TPWC	EPBC				
AMARANTHACEAE	*Tecticornia halocnemoides* subsp. *tenuis*	DD	-	Shrub	Spreading or erect shrub to 50 cm high; branchlets green or red. Articles narrowly barrel-shaped, c. 5 mm long, c. 2 mm wide, dull to glossy, entire.	Salt pans	Low
ARALIACEAE	*Trachymene villosa*	DD	-	Herb	Annual herb to 1m high. Flowers in simple umbels in pink/white. July. Leaves ternately divided or rarely only toothed.	Skeletal soils over quartzite	High
AIZOACEAE	*Trianthema glossostigma*	NT	-	Herb	Prostrate, much branched annual, herb to 0.02-0.1m high. Flowers white and pink/purple. Pioneer species in disturbed, flat areas	Rocky sandy soils, lateritic loam. Plains, ridges	High
AIZOACEAE	*Trianthema oxycalyptra* var. *oxycalyptra*	NT	-	Herb	Prostrate to decumbent annual, herb, 0.01-0.1 m high, flowers pink-purple, Jan to Nov	Sandy soils, clay, often saline	Low
ZYGOPHYLLACEAE	*Tribulus* sp. *long-styled eichlerianus*	DD	-	Herb	Annual, prostrate, groundcover herb. Flowers large, erect, bright yellow.	Information unavailable.	Low
MALVACEAE	*Triumfetta clivorum* subsp. *brevipetala*	DD	-	-	Information unavailable.	Information unavailable.	Low

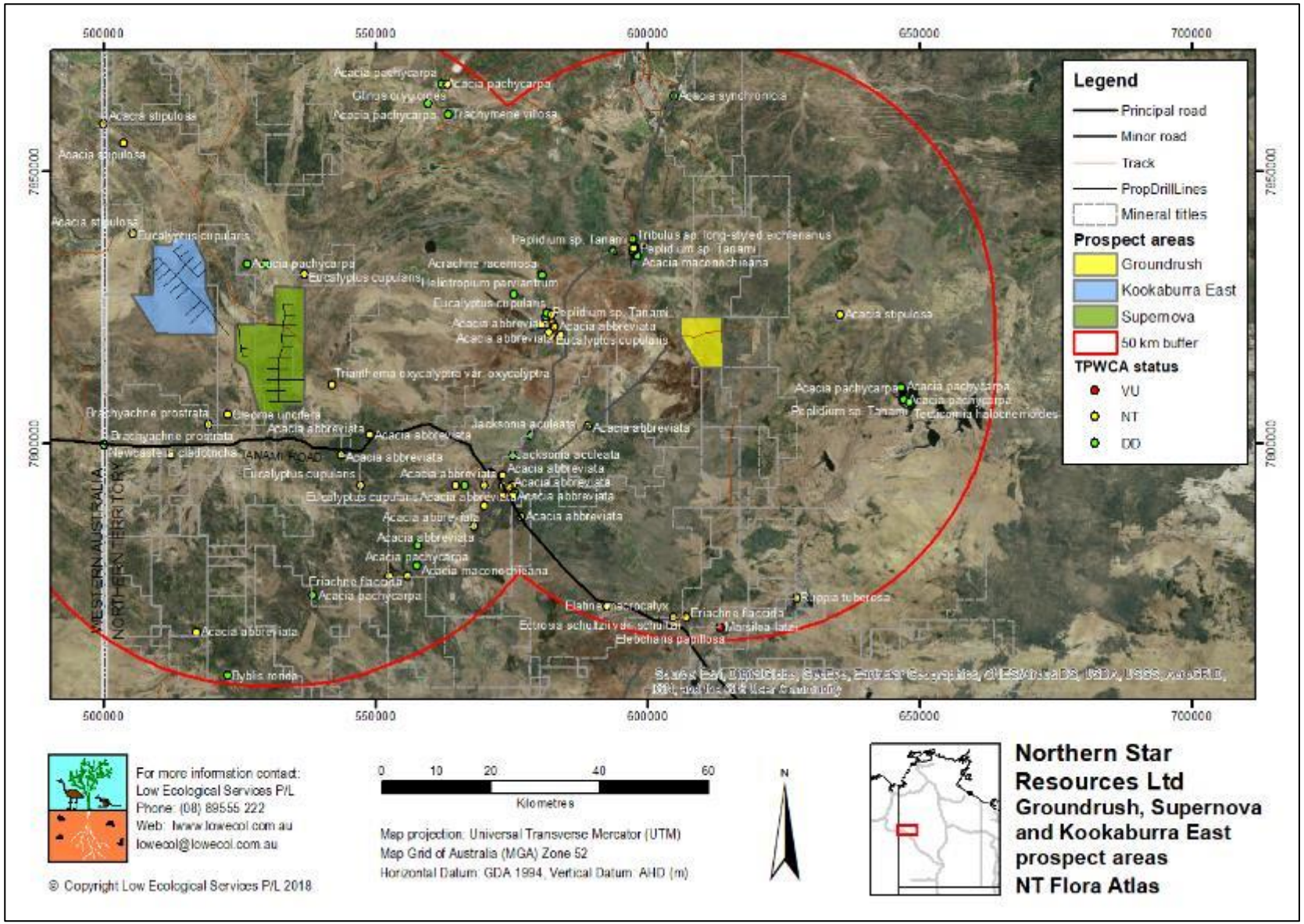

Figure 10. Flora species of conservation significance identified by the NT Flora Atlas as occurring within 50 km of the Groundrush, Supernova and Kookaburra East prospect areas. VU: vulnerable, NT: near threatened, DD: data deficient.

3.9.4 Introduced flora species

Weeds of National Significance (WoNS) are declared based on invasiveness, potential for spread and environmental, social and economic impacts. Strategic plans for WoNS are developed as a result of their declaration, which define responsibilities and identifies strategies and actions to control the species. Landholders and managers are ultimately responsible for managing WoNS, and the state/territory government is responsible for overall legislation and administration (Department of Sustainability, Environment, Water, Population and Communities, 2012).

In the NT, a plant is declared a weed if it has been identified for control, eradication or prevention of entry into the NT. All landholders, land managers and land users must comply with the declaration classification. Based on the risk of harm they could cause and how difficult they are to control, weeds are placed into the following classes:

- Class A – to be eradicated
- Class B – growth and spread to be controlled
- Class C – not to be introduced into the NT

Eight introduced flora species were identified as occurring within 50 km of the survey areas by the NT Weeds dataset. None of these species are declared under the Weeds Management Act or are WoNS. However, four weed species; ruby dock (*Acetosa vesicaria*), kapok bush (*Aerva javanica*), buffel grass (*Cenchrus ciliaris*) and *Chloris* sp. are moderately likely to occur in the prospect areas if appropriate mitigating measures are not taken to prevent their introduction. Prevention techniques, such as washing of vehicle wheels, will aid in preventing introduction and spread, particularly through previously uncleared areas. Other weeds known to occur in the Tanami bioregion are Mossman river grass (*Cenchrus echinatus*) (Class B), buffel grass (*Cenchrus ciliaris*) and umbrella sedge (*Cyperus involucratus*). Couch grass (*Cynodon dactylon*) is also likely to be spreading (Thackway & Cresswell, 1995), but is unlikely to find appropriate habitat in the prospect areas.

4 FIELD SURVEY RESULTS

4.1 Survey Conditions

The survey was conducted during mid-summer from 12th-14th February 2018. Climatic conditions during the survey were extremely hot and humid with periodic thunderstorms circulating in the region. Rainfall in the month preceding the survey, was lower than average, with 101.4 mm of rain recorded at the Rabbit Flat weather station located approximately 60 km south-west of the survey sites (Bureau of Meteorology, 2018).

4.2 Flora species

A total of 111 species from 29 families were identified during the on-ground survey (Appendix 3). Included in this list are five flora species of conservation significance and 15 species of cultural significance to Warlpiri people.

4.2.1 Conservation Significant Flora

A total of five conservation significant flora species were recorded in the surveyed areas (Table 7). Several flora species could not be identified to species level due to lacking identifying features such as flowers and fruits.. However, all were determined not to be threatened or of other conservation significance due to their identified genus, description and/or location.

Table 7. Flora species of conservation significance identified in the on-ground survey at Groundrush, Supernova and Kookaburra East prospect areas. VU: vulnerable, NT: near threatened, DD: data deficient.

Family	Scientific name	Status		Habit	Description	Habitat	Location Observed
		TPWC	EPBC				
Cleomaceae	*Cleome uncifera* ssp. *microphylla*	NT	-	Shrub	Low spreading, densely-branched shrub, to 0.5 m high. Flowers yellow, May to Nov.	Red sand and sand dunes.	Supernova (S2)
Boraginaceae	*Heliotropium subreniforme*	DD	-	Herb	Upright, multi-stemmed fine herb, to 30 mm tall, opposite 5mm leaves at nodes, white flowers.	Sandy soils.	Kookaburra East (K4)
Malvaceae	*Hibiscus brachychlaenus*	NT	-	Herb	Upright, spreading perennial, herb or shrub, 0.4-1.8 m high, to 1 m wide. Flowers are blue-purple-pink, Mar to Apr or Aug to Nov.	Sandy & loamy soils, sandstone. Sandplains, sand dunes.	Kookaburra East (K1)
Fabaceae	*Jacksonia aculeata*	DD	-	Shrub	Divaricate, somewhat spiny shrub, 0.2-1m high. Flowers yellow/yellow orange April to October	Red sand. Sand dunes and sandplains.	Kookaburra East (K1)
Phyllanthaceae	*Sauropus trachyspermus*	NT	-	Herb	Slender, broom-like perennial, herb or shrub, 0.1-0.6 m high. Flowers are cream-green, Jan or Apr to Jun.	Sandy soils over sandstone, clay. Flats, floodplains, among sandstone boulders.	Kookaburra East (K4)

4.2.2 Culturally Significant Flora

Fifteen flora species were identified by the Northern Tanami Rangers at the survey sites as being culturally significant to Warlpiri and Gurindji Indigenous peoples (Table 8). Additional information of culturally significant species recorded at survey sites has been included drawing reference from Latz (1995). While none of these culturally significant species are listed as threatened or of other conservation significance under the TPWC and EPBC Acts, protection of these species when undertaking work in these prospect areas is recommended and where ever possible for operations to try to minimise impacts on these species abundance.

Table 8. Flora with cultural and socio-economic significance to Warlpiri Traditional Owners.

Warlpiri Name	Scientific Name	Common Name	Uses	Location Observed (Transect #)
kunarnturu, pangkuna, wakirlpirri	*Acacia coriacea*	Dogwood	Edible seeds. Wood is used for boomerangs while spears are made from the roots. Used in waterholes to catch fish.	Groundrush (G2, G4, G5), Kookaburra East (K1, K2, K3, K4, K5), Supernova (S1,S2)
murlurrpa	*Acacia lysiophloia*	Turpentine	Edible seeds. Medicinal plant used to smoke mothers and babies and for skin irritations.	Groundrush (G1, G5), Kookaburra East (K2)
ngirnti-yirrpi, kurapuka	*Acacia stipuligera*	-	Edible seeds and gum.	Groundrush (G1, G2), Kookaburra East (K4, K5), Supernova (S1, S3)
kulaki, kuwiyangayi, minyana, nyintirriyilpi, waltiyawarnu	*Acacia tenuissima*	-	Edible seeds, medicinal and used to build dwellings.	Supernova (S1)
***Tree**: wirrkali, wurrkali, yurrkali* ***Galls:** Jalarla-payi-payi, kanta, kajipu,mangarrayi, mawu, yanturi*	*Corymbia opaca*	Desert Bloodwood, Bush Coconut	Food, water, medicine, cement, decoration. Frequently features in Aboriginal mythology.	Groundrush (G1, G5), Kookaburra East (K2)
ngurlu, wangunu, warnaralpa	*Eragrostis eriopoda*	Woolybutt Grass	Seeds are a traditional staple food. Important in ceremonies, songs and mythology.	Groundrush (G2)
jitilpuru, juturlpuru, walyilpi, warrilyi	*Eucalyptus pachyphylla*	Red Mallee	Edible honey and lerp scale often on leaves.	Groundrush (G1, G4), Supernova (S2, S3)
walunarri, wirrpinyaru, wiyinyari, yurltukunpa	*Grevillea juncifolia*	Honey Grevillea	Edible flowers and medicinal bark.	Kookaburra East (K1)

Warlpiri Name	Scientific Name	Common Name	Uses	Location Observed (Transect #)
karlkarangi, lakarrpara, pijalapanpa	*Grevillia wickhamii*	Holy leaf Grevillia	Clear gum exuding from its branches is eaten.	Groundrush (G1), Kookaburra East (K2, K4, K5), Supernova (S1, S3)
watikinpi, yanjalingki, yinjalingkalingi, yukunji	*Hakea macrocarpa*	-	Edible flowers. Ritual significance and features in Snake Dreaming.	Kookaburra East (K1), Supernova (S3)
***Fruits**: yangardurku, yurnturrngu*	*Marsdenia australis*	Bush Banana	Edible fruits, leaves, flowers. Important in mythology and as decoration in ceremonies.	Supernova (S3)
marrkirdi, makaki, yankurlayi	*Santalum lanceolatum*	Plum Bush, Wild Plum	Edible fruits.	Supernova (S2)
wanakiji	*Solanum chippendalei*	Bush Tomato	Edible fruits. Features in mythology and in ceremonies.	Groundrush (G1)
wangki	*Solanum ellipticum*	Native Tomato, Potato Bush, Wild Gooseberry	Edible fruits. Features in mythology.	Groundrush (G5)
***Plant:** marna, manyangarnpa* ***Resin:** palya*	*Triodia pungens*	Soft Spinifex	Resin occurring at base of plant is used for cementing and as an adhesive. Resinous anthill under tussock is used of medicinal purposes.	Groundrush (G2,G3,G5), Kookaburra East (K1, K2, K3, K4, K5), Supernova (S1, S3, S4)

4.2.3 Introduced Flora Species

The introduced buffel grass (*Cenchrus ciliaris*) was observed dominating groundcover of disturbed soil areas at Northern Star Tanami mine camp and Groundrush mining operations site. Similarly, buffel grass is also found at the near by mine site operated by Newmont, 100 km south west of the Northern Star mine camp. Soil disturbances induced by mining operations and the transportation of weed species seeds on machinery and vehicles across the Northern Territory is a challenge for containing the spread of introduced species into surrounding pristine ecosystems. It is recommended that appropriate mitigating measures, such as washing of the entire vehicle including wheels before entering all sites, are implemented to aid in preventing the introduction and spread of weed species, particularly into previously undisturbed areas. Where possible, it is advisable to control the spread of *C. ciliaris*, and other weed species, from known locations using appropriate techniques such as chemical spraying, physical removal and rehabilitation.

4.3 Habitat types in the survey area

Eight habitats were identified by recorded site descriptions of the on-ground survey. These included a laterite dome, rocky rise, rocky ridge, paleochannel and sandy floodplain areas of predominately open woodland and shrublands. These habitat types are described in detail below. Where possible, specific habitat/substrate indicators, such as flora species and geological or ecological features, have been identified to aid Northern Star staff in future survey effort.

Table 9. Habitat types in the survey areas; Groundrush, Kookaburra East and Supernova. Sites surveyed were 50x50m quadrats.

Habitat	Survey area	Sites	Description	Photograph
Laterite dome, low open-woodland with *Corymbia opaca* over *Acacia adoxa* and *Amphibogon caricinus*	Groundrush	G1	Mid slope, laterite rise of small rocks (6-20cm) overlying clay loam soils with 30% vegetation cover, 15% vegetation litter, 25% rock cover (laterite) and 30% bare soil as a crust. The vegetation community consists of low open- woodland of isolated Bloodwood (*C. opaca)* and Corkwood *(Hakea lorea)* over a midstorey of *Grevellia whickhamii* and *Acacia stipuligera.* Lower storey is dominated by *Acacia adoxa*, *Amphipogon caricinus and Rulingia loxophylla.* This site was unburnt in recent 2017 fires that encompassed nearly all the Groundrush prospect site. Vegetation maturity indicates the last fire burnt this area over 2 years ago. Tower shaped termite mounds up to 0.5 m tall are present at a rate of 25 in the quadrat. Non-dominant species: *Eucalyptus pachyphylla, Rulingia loxophylla, Acacia lysiophloia, Dampiera candicans, Gossyypium australe.*	

Photo: Groundrush site quadrat G1; 12th Feb 2018 (Low Ecological Service P/L)

Habitat	Survey area	Sites	Description	Photograph
Sandplain floodplain of low woodland over emergent open hummock grasslands	Groundrush	G2, G3, G4, G5	Gently sloping drainage sandplain habitat which was recently burnt in 2017. Sandy loam soils had coverage of 35% ground vegetation, 60% bare soil and vegetation litter 5%. Between 60 - 160 tower shaped termite mounds from 0.3 m to 1 m tall were present in the quadrat. Vegetation coverage of sparse woodland dominated by Bloodwoods (*C. opaca)*, Dogwoods *(Acacia coriacea)* over Desert rose (*Gossypium sturtarium)*, *Acacia stipuligera* and *Acacia lysiophloia*. Grasses such as Woollybutt (*Eragrostis eriopoda*), Soft spinifex (*Triodia pungens*) and *Eragostis setifolia* in juvenile stages of growth sparsely covered the ground. Non-dominant species: *Paraneurachne muelleri, Aristida holothera, Rulingia loxophylla, Haloragis aspera, Amphipogon caricinus, Eucalyptus pachphylla, Amaranthus interruptus*.	 Photo: Groundrush site quadrat G2; 12th Feb 2018 (Low Ecological Service P/L).
Woodland of *Eucalyptus brevifolia*, *A. coriacea* and *Melaleuca lasiandra* on sloping sandplain	Kookaburra East	K1	Long unburnt woodland on sandy soils with 65% ground vegetation coverage, 25% bare soil and 10% vegetation litter. Overstorey is dominated by mature *Eucalyptus brevifolia*, *A. coriacea* and *Melaleuca lasiandra* over *Grevillea junicifolia, Jacksonia aculeate, Gossyipium sturtanium* and grasses; *T. pungens* and *Aristida holothera.* Eight tower shape termite mounds present in the 50x50m quadrat up to 1m tall. Non-dominant species: *Halgania sp., Abutilon macrum, Sida filiformis, Hibiscus bracychlaenus, Hakea macrocarpa, senna costata.*	 Photo: Kookaburra East site quadrat K1; 13th Feb 2018 (Low Ecological Service P/L)

Habitat	Survey area	Sites	Description	Photograph
Sandy floodplain, open hummock grasslands with isolated *Acacia coriacea* and *Corymbia opaca*	Kookaburra East, Supernova	K2, K3, K5, S1	Sloping sandplain floodplain of open hummock grassland and low open-woodland. Overstorey consists of *A. coriacea, C. opaca* and mid-storey; *Acacia lysiophloia* and *Grevillea whikhamii*. The dominate lower stories includes a community of Soft spinifex (*T. pungens)* and *Heliotropium ovalifolium.* Vegetation coverage is 40 % with 55% bare soil and 5% vegetation litter present. A crust is present over 50% of the bare soil. Vegetation has not been burnt in the last 2 years. Tower shaped termite mounds up to 1.3 m tall are in abundance of 30- 120. Non-dominant species: *Clerodendrum floribundum, Fimbristylis dichotoma, Olearia ferresii, Vigna lanceolata, Aristida inaequiglumis, Scaevola spinescens, Halgania cyania, Acacia tenuissima, Cassytha* sp.*, Amphipogon carincinus.*	 Photo: Kookaburra East site quadrat K2; 13th Feb 2018 (Low Ecological Service P/L)
Sandplain paleochannel with low woodland over perennial grasslands	Kookaburra East	K4	Paleochannel habitat of shallow sandy loam soils characterised by large dome termite mounds up to 2.5 m high with 140 occurring within the quadrat. Soils are 70% vegetated, 25% bare soil and 5% vegetation litter. A clear crust is present covering 75% of bare soils. Low woodland of *A. coriacea, C. opaca* and with a mid-storey of *Acacia stipuligera* and *Grevillea whikhamii*. Lower storey is diverse in grasses and sedges including *Aristida holothera*, *Bulbostylis barbata, Eulalia aurea* and *Chrysopogon fallax*. Non-dominant species: *Digitaria brownie, Hybanthus aurantiacus, Heliotropium subreniforme, Evolvulus alsinoides, Senna pleurocarpa, Gossypium australe, Sauropus trachyspermus.*	 Photo: Kookaburra East site quadrat K4; 13th Feb 2018 (Low Ecological Service P/L)

Habitat	Survey area	Sites	Description	Photograph
Deep sandy rise with tall shrubland	Supernova	S2	Long unburnt tall shrubland over deep sands indicated by the presence of Bush plum *(Santalum lanceolatum).* Vegetation coverage is 50%, bare soil 40%, rock cover 5% and vegetation litter 5%. Small colluvium pebbles are present on the soil surface and a crust cover 20% of bare soil areas. Unlike other surveyed sites no termite mounds are present here. Shrubland is dominated by an overstorey of Dogwood (*A. coriacea*), *Santalum lanceolatum, Jacksonia odontoclada* and a lower storey of *Rulingia loxophylla* and *Eriachne helmsii*. Non-dominant species: *Eucalyptus odntocarpa, Aristida holothera, Paraneurachne muelleri, Dicrastylis exsuccosa, Gossypium australe, Cleome uncifera* ssp. *microphylla.*	 Photo: Supernova site quadrat S2; 12th Feb 2018 (Low Ecological Service P/L)
Rocky rise, tall shrubland	Supernova	S3	Rocky rise upper slope dominated by tall shrubland of *Dodonaea viscosa, Acacia melleodora* and *Hakea macrocarpa* and lower storey of *Acacia adoxa, T. pungens* and *T. intermedia*. Soils are covered with 35% quartzite stone leaving 5% bare soil, 1% vegetation litter and 49% long unburnt vegetation coverage. Soils were moderately deep (10-40 cm) sandy loams with quartzite rocky cover up of 90%. Non-dominant species: *Eucalyptus socialis, Acacia hilliana, Grevillea whikhamii, Mirbelia viminalis, Eucalptus pachyphylla, Marsdenia australis.*	 Photo: Supernova site quadrat S3; 14th Feb 2018 (Low Ecological Service P/L)

Habitat	Survey area	Sites	Description	Photograph
Rocky ridge, low open-shrubland	Supernova	S4	Exposed rocky ridge slope covered by low open shrubland of *T. pungens*, *T. intermedia* and *Acacia hilliana*. Small rocks (6-20 cm) of eroded quartzite covered 50% of the ground. Ground vegetation represented 30% of coverage and outcropping rock 20%. Termite mounds to the height of 0.3 m were dotted on lower slopes (12 counted) in the quadrat. A black crust of 2% coverage was recorded. Non-dominant species: *Halgania cyania, Hakea loera ssp. lorea, Paraneurachne muelleri, Dodonaea coriacea, Hybanthus aurantiacus, Trianthema oxycalyptrum, Codonocarpus cotinifolius.*	 Photo: Supernova site quadrat S4; 14th Feb 2018 (Low Ecological Service P/L)

5 RECOMMENDATIONS

The following recommendations are provided as a guide for future proposed drilling operations within the Groundrush, Kookaburra East and Supernova:

- Avoid the removal of mature trees such as Bloodwoods, Dogwoods, other large Eucalypts and large Acacias as these take a long time to regenerate from seed. These scattered trees are keystone structures that provide several ecological functions including; provision of a distinct microclimate, increased soil nutrients and plant species richness, increased structural complexity and habitat for animals (Manning, Fischer, & Lindenmayer, 2006). At the landscape scale, ecological roles of these trees also provide increased landscape-scale tree cover; increased connectivity for animals; increased genetic connectivity for tree populations; and provision of genetic material (Manning, Fischer, & Lindenmayer, 2006).

- Tracks between drill sites should be prepared with minimal earthworks by keeping the grader blade at or above surface level to remove stakes and vegetation but not grading the soil if it is not necessary. Similarly, when clearing the drill pads for this minimal impact drilling to relatively shallow depth, remove top soil only where necessary and replace it when drilling is complete. The quicker the topsoil can be put back on the rehab sites, the better the revegetation.

- Current research by the CSIRO unveils new Gold exploration techniques that x-ray eucalyptus tree leaves for gold particles taken up by deep root systems (Frazer, 2018). This method minimises the impacts on flora and fauna posed by drilling techniques and should be considered in future exploration applications. (See for more details https://blog.csiro.au/athletes-arent-the-only-ones-going-for-gold/)

- No earthworks be undertaken under the canopy of trees when undertaking drilling operations. Many of these larger trees are culturally significant species to Warlpiri people (see Table 8).

- The five species of conservation significance, both data deficient and near threatened species, located within survey sites are small herbs and shrubs that are encouraged to be identified prior to drilling using the Flora Identification Booklet provided with this report. Minimal disturbance is recommended where these species are located. If Northern Star staff are unable to identify a flora species or think that a plant might be unique, then it is encouraged that they take a photo of the plant and email to Low Ecological Services P/L. If appropriate, take a small specimen (not the entire plant) including a fruit and/or flower to be pressed and sent to Low Ecological Services P/L for identification and subsequent entry into NT Flora and Fauna Atlas. See Appendix 4 and 5 for Site Description Form and Plant Label Form to be filled out. In order to collect plants in the Northern Territory both an ethics application and a permit 'to take or interfere with wildlife' need to be approved by an Ethics Board and the Northern Territory Government. If possible, any drill site access and development should minimise destruction of questionably significant species.

- Staff awareness of culturally significant species to local Warlpiri people is recommended and where possible exploration operations should minimise impacts on these species.

- To prevent weeds spreading and introduction into newly disturbed areas appropriate mitigation measures such as full vehicle washdown before entering sites need to be carried out. C. ciliaris (buffel

grass) is flagged as a major risk plant as an increase in could lead to more frequent and intense fires that significantly impact native flora and fauna communities.

Following these recommendations will ensure that any proposed development activities in the Groundrush, Supernova and Kookaburra East prospect areas are unlikely to have any significant impact on the population of any species of conservation and cultural significance in the region.

6 CONCLUSION

This flora assessment report details both a desktop assessment and on-ground flora survey conducted by Low Ecological Services P/L.

The desktop assessment identified thirteen near-threatened flora species and 18 data deficient species recorded within the NT Flora Atlas database as occurring within a 50 km radius of the Groundrush, Supernova and Kookaburra East prospect areas. One species of national conservation significance, the dwarf desert spike-rush (*Eleocharis papillosa*), vulnerable, was identified by the EPBC PMST as potentially occurring within the area, but this is unlikely due to lack of appropriate habitat. Five additional data deficient flora species considered significant in the bioregion were also identified as occurring in the region. Of these species, 11 were assessed as having a high likelihood of occurring within the three prospect areas.

Accompanying this desktop assessment, a three day on-ground survey was conducted on the 12th-14th February 2018 by Low Ecological Services P/L staff alongside Northern Star Resources Ltd staff and the North Tanami Rangers. The survey provided a further understanding of the area to be impacted by the proposed drilling and identified key flora species within representative habitat sites. It also served as a training workshop for participants in key flora identification, specimen collection which will assist in future internal exploration pre-clearance surveys at these respective sites. Survey results identified 111 species from 29 families recorded during the on-ground survey. Five species of conservation significance were identified including three near-threatened species (*Cleome uncifera* ssp. *microphylla, Hibiscus brachychlaenus, Sauropus trachyspermus*) and two data deficient species (*Jacksonia aculeata, Heliotropium subreniforme*). Fifteen culturally and socio-economically significant species for Warlpiri people were also identified by the North Tanami Rangers and resource manuals.

It is recommended that removal of mature trees be avoided, and no earthworks be undertaken under the canopy of the trees when undertaking drilling operations. Awareness of culturally significant species for Warlpiri people is suggested and efforts be made to minimise impacts of the abundance of these species. Significant species can be identified using the Flora Identification Booklet and then protected from disturbance. Earthworks should be minimised where possible, such as on access tracks and parts of the drill pads where it is not necessary to remove topsoil. If topsoil is removed it should be stockpiled separately and reinstated on the rehabilitated land as soon as possible after the drilling is completed.

While no introduced flora species were identified during the field survey, four weed species (ruby dock, kapok bush, buffel grass and *Chloris* sp.) are moderately likely to occur in the prospect areas if appropriate mitigation measures, such as vehicle wash down, are not taken to prevent their introduction.

Following these measures and recommendations will ensure that any proposed development activities in the Groundrush, Supernova and Kookaburra East prospect areas are unlikely to have any significant impact on species of conservation and cultural significance in the region.

7 REFERENCES

Ahmad, M. (2000). *Geological map of the Northern Territory, 1:2,500,000.* Northern Territory Geological Survey.

Ashton, L., & McKenzie, N. (2001). *Conversion of the Atlas of Australian Soils to the Australian Soil Classification (ASC).* CSIRO Land and Water (unpublished).

Baker, B., Price, O., Woinarski, J., Gold, S., Connors, G., Fisher, A., & Hempel, C. (2005). *Northern Territory bioregions - assessment of key biodiversity values and threats.* Darwin: Department of Natural Resources, Environment and the Arts.

Bureau of Meteorology. (2016). *Climate Data Online*. Retrieved October 5, 2016, from http://www.bom.gov.au/climate/data/

Bureau of Meteorology. (2017). *Climate Data Online*. Retrieved February 10, 2017, from http://www.bom.gov.au/climate/data/

Bureau of Meteorology. (2018). *Climate Data Online*.

Department of Sustainability, Environment, Water, Population and Communities. (2012). *Australia's bioregions (IBRA)*. Retrieved January 29, 2012, from http://www.environment.gov.au/parks/nrs/science/bioregion-framework/ibra/index.html

Department of Sustainability, Environment, Water, Population and Communities. (2012). *Weeds of National Significance*. Retrieved September 18, 2012, from Department of Sustainability, Environment, Water, Population and Communities web site: http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html

Department of the Environment and Energy. (2017). *Species Profile and Threats Database*. Retrieved February 17, 2017, from http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

DoE. (2015a). *Protected Matters Search Tool.* Retrieved October 2015 2015, from Department of Sustainability, Environment, Water, Population and Communities Website: http://www.environment.gov.au/epbc/pmst/index.html

Domahidy, G. (1990). *Hydrogeology of The Granites - Tanami Mining Region. Explanatory notes for the 1:250000 Scale Map.Report 74 .* Northern Territory: Power and Water Authority.

Duguid, A., Barnetson, J., Clifford, B., Pavey, C., Albrecht, D., Risler, J., & McNellie, M. (2005). *Wetlands in the arid northern Territory. A report to the Australian Government Department of the Environment and Heritage on the inventory and significance of wetlands in the arid Northern Territory.* Alice Springs: Northern Territory Government Department of Natural Resources Environment and the Arts.

Foster, E., & Low, W. (2004). *A Framework for Regional Monitoring of Selected Wildlife in the Tanami. Report to Newmont Tanami Pty Ltd.* Alice Springs, NT.

Frazer, S. (2018, April 6). *Athletes aren't the only ones going for gold*. Retrieved from CSIRO scope: https://blog.csiro.au/athletes-arent-the-only-ones-going-for-gold/

Holmes, J., & Low, W. A. (2000). *Environmental Impact Assessment of the Proposed Haulroad from the Groundrush Prospect Evaluation Area to Tanami Mine. .* Wayville, S.A.: Normandy North Flinders Mining Ltd.

Isbell, R., & National Committee on Soil and Terrain. (2016). *The Australian Soil Classificatoin 2nd ed.* CSIRO Publishing.

Latz, P. (1995). *Bushfires and Bushtucker: Aboriginal Plant Use in Central Australia.* Alice Springs: IAD Press.

Low, W. A., Fowler, M., & Nelson, D. J. (1994). *Landscape, flora and vertebrate fauna survey of the CDJV project area at Redback, Dogbolter and Jims south of Tanami Well. Report for Billiton Australia, Melbourne. Appendix C In central Desert Joint Venture Project Preliminary Environmental Report.* Melbourne: NSR Environmental Consultants.

Low, W., Holmes, J., Vea, J., & Davies, B. (2001). *Schist Hills borefield vegetation survey: water extraction impact assessment and vegetation monitoring program, November 2000. Report to Normandy Mining Limited, Normandy Tanami Operations.* Alice Springs, NT.

Manning, A., Fischer, J., & Lindenmayer, D. (2006). Scattered trees are keystone structures - Implications for conservation. *Biological Conservation*, 132: 311-321.

North Australia and Rangelands Fire Information. (2017). North Australia and Rangelands Fire Information downloadable data. Retrieved October 31, 2017, from www.firenorth.org.au

Northcote, K. (1968). *Atlas of Australian Soils.* Melbourne: CSIRO and Melbourne University Press.

NSW Government. (2009). *Collecting and preparing plant specimens.* Retrieved from PrimeFacts: file:///E:/Letter_Sara/Tanami%20Gold/NorthernStar/Threatened%20Flora%20project%202018/Collecting-and-preparing-plant-specimens-for-identification.pdf

Oliver, I., Holmes, A., Dangerfield , M., Gillings, M., Pik, A., Britton D. , . . . Beattie, A. J. (2004). Land systems as surrogates for biodiversity in conservation planning. *Ecological Applications, 14*(2), 485-503.

Perry, R. A., Mahbbutt, J. N., Litchfield, W. H., & Quinlan, T. (1960). *Land Systems of the Alice Springs Area, Northern Territory, Australia: CSIRO Land Research Series No. 6.* CSIRO.

Thackway, R., & Cresswell, I. D. (1995). *An Interim Biogeographic Regionalisation for Australia: a framework for setting priorities in the national reserves system cooperative program.* Canberra: Commonwealth of Australia.

White, M., Albrecht, D., Duguid, A., Latz, P., & Hamilton, M. (2000). *Plant species and sites of botanical significance. Volume 2: Significant sites. Part 1: Sites of significance.* Alice Springs: Arid Lands Environment Centre.

Wilford , J. R., & Butrovski, D. (1999). *Tanami Granites Regolith-Landforms Map Series (1:100,000 map scale).* CONFIDENTIAL.

Wilson, B. A., Brocklehurst, P. S., Clark, M. J., & Dickinson, K. J. (1990). *Vegetation Survey of the Northern Territory, Australia.* Darwin: Conservation Commission of the Northern Territory.

8 APPENDICES

Appendix 1. Location of sites, in GDA94 co-ordinate system, surveyed during the February 2018 on-ground flora survey by Low Ecological Services P/L.

Survey area	Site	Latitude	Longitude
Groundrush	G1	-19.68639504	130.06166667
	G2	-19.70604696	130.07333333
	G3	-19.71614504	130.03527778
	G4	-19.70975497	130.00722222
	G5	-19.73943904	130.01666667
Kookaburra East	K1	-19.66418598	129.15194444
	K2	-19.64541327	129.13638889
	K3	-19.61972898	129.12361111
	K4	-19.60624300	129.10027778
	K5	-19.58436297	129.13694444
Supernova	S1	-19.69979404	129.31388889
	S2	-19.73632103	129.31388889
	S3	-19.78822400	129.30527778
	S4	-19.79451597	129.30027778

Appendix 2. EPBC PMST Report for the Groundrush, Supernova and Kookaburra East prospect areas and approximately 50 km surrounding land.

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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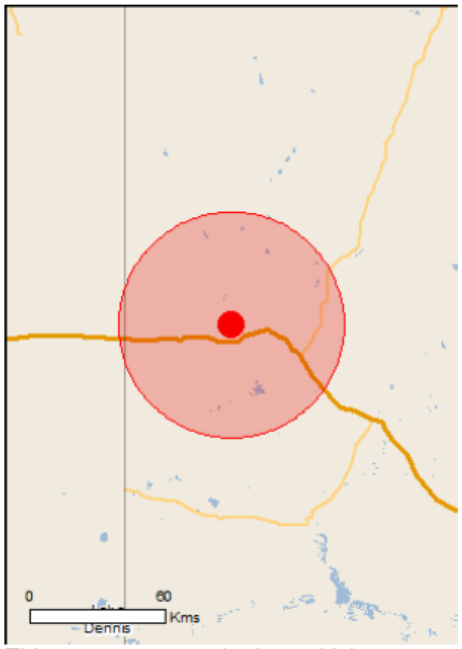

This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	7
Listed Migratory Species:	11

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	15
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	9
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat may occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Mammals		
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area
Zyzomys pedunculatus Central Rock-rat, Antina [68]	Endangered	Species or species habitat may occur within area
Reptiles		
Liopholis kintorei Great Desert Skink, Tjakura, Warrarna, Mulyamiji [83160]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Northern Tanami	NT

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-19.84287 129.42574

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix 3. Flora list from the February 2017 on-ground survey of Groundrush, Kookaburra East and Supernova prospect areas.

		Groundrush					Kookaburra East					Supernova			
Family	**Scientific name**	**G1**	**G2**	**G3**	**G4**	**G5**	**K1**	**K2**	**K3**	**K4**	**K5**	**S1**	**S2**	**S3**	**S4**
Malvaceae	*Abutilon fraseri*												X		
Malvaceae	*Abutilon macrum*						X								
Malvaceae	*Abutilon otocarpum*									X					
Fabaceae	*Acacia adoxa*	X												X	
Fabaceae	*Acacia ancistrocarpa*											X			
Fabaceae	*Acacia coriacea*		X		X	X	X	X	X	X	X	X	X		
Fabaceae	*Acacia hilliana*	X												X	X
Fabaceae	*Acacia holosericea*										X				
Fabaceae	*Acacia lysiophloia*	X				X		X							
Fabaceae	*Acacia melleodora*													X	
Fabaceae	*Acacia sericophylla*				X										
Fabaceae	*Acacia stipuligera*	X	X							X	X	X		X	
Fabaceae	*Acacia tenuissima*											X			
Amaranthaceae	*Amaranthus interruptus*					X									
Poaceae	*Amphipogon caricinus*	X	X	X	X							X			
Poaceae	*Aristida holothera*	X	X	X			X		X	X	X		X		
Poaceae	*Aristida inaequiglumis*		X		X	X					X				
Nyctaginaceae	*Boerhavia schomburgkiana*						X								
Convolvulaceae	*Bonamia media*									X					
Cyperaceae	*Bulbostylis barbata*									X					
Capparaceae	*Capparis umbonata*											X			
Lauraceae	*Cassytha capillaris*		X												
Lauraceae	*Cassytha sp.*										X	X			
Poaceae	*Chrysopogon fallax*									X					
Cleomaceae	*Cleome uncifera ssp. microphylla*												X		
Lamiaceae	*Clerodendrum floribundum*								X						
Gyrostemonaceae	*Codonocarpus cotinifolius*														X

		Groundrush					Kookaburra East					Supernova			
Family	**Scientific name**	**G1**	**G2**	**G3**	**G4**	**G5**	**K1**	**K2**	**K3**	**K4**	**K5**	**S1**	**S2**	**S3**	**S4**
Malvaceae	*Corchorus sidoides*						X	X							
Myrtaceae	*Corymbia opaca*	X				X		X							
Myrtaceae	*Corymbia candida*			X											
Fabaceae	*Crotalaria eremaea*			X											
Poaceae	*Cymbopogon obtectus*		X			X									
Cyperaceae	*Cyperus concinnus*									X					
Cyperaceae	*Cyperus cunninghamii*									X					
Cyperaceae	*Cyperus bulbosus*											X			
Goodeniaceae	*Dampiera candicans*	X	X												
Lamiaceae	*Dicrastylis exsuccosa*			X		X					X		X		
Lamiaceae	*Dicrastylis sp.*		X												
Poaceae	*Digitaria brownii*									X		X			
Sapindaceae	*Dodenaea coriacea*														X
Sapindaceae	*Dodenaea viscosa*													X	
Bignoniaceae	*Dolichandrone heterophylla*									X					
Poaceae	*Eragrostis eriopoda*		X												
Poaceae	*Eragrostis setifolia*		X	X	X										
Poaceae	*Eriachne helmsii*												X		
Myrtaceae	*Eucalyptus brevifolia*						X								
Myrtaceae	*Eucalyptus gamophylla*				X										
Myrtaceae	*Eucalyptus odontocarpa*												X		
Myrtaceae	*Eucalyptus pachyphylla*	X			X								X	X	
Myrtaceae	*Eucalyptus socialis*													X	
Poaceae	*Eulalia aurea*									X	X				
Euphorbiaceae	*Euphorbia tannensis*								X						
Convolvulaceae	*Evolvulus alisinoides*									X					
Convolvulaceae	*Evolvulus alsinoides var. decumbens*						X								
Cyperaceae	*Fimbristylis dichotoma*								X						

		Groundrush					Kookaburra East					Supernova			
Family	**Scientific name**	**G1**	**G2**	**G3**	**G4**	**G5**	**K1**	**K2**	**K3**	**K4**	**K5**	**S1**	**S2**	**S3**	**S4**
Goodeniaceae	*Goodenia virgata*		X												
Malvaceae	*Gossypium australe*	X								X			X		
Malvaceae	*Gossypium sturtarium*		X		X	X	X								
Proteaceae	*Grevillea juncifolia*						X								
Proteaceae	*Grevillea whickhamii*	X						X		X	X	X		X	
Proteaceae	*Hakea lorea spp. lorea*														X
Proteaceae	*Hakea macrocarpa*						X							X	
Boraginaceae	*Halgania cyania*										X	X	X		X
Boraginaceae	*Halgania sp.*	X						X							
Haloragaceae	*Haloragis aspera*		X												
Boraginaceae	*Heliotropium glabellum*											X			
Boraginaceae	*Heliotropium haesum*				X										
Boraginaceae	*Heliotropium leptaleum*	X													
Boraginaceae	*Heliotropium ovalifolium*							X		X		X			
Boraginaceae	*Heliotropium skeleton*			X											
Boraginaceae	*Heliotropium subreniforme*									X					
Malvaceae	*Hibiscus brachychlaenus*						X								
Malvaceae	*Hibiscus sp.*									X		X			
Violaceae	*Hybanthus aurantiacus*	X								X					X
Fabaceae	*Indigofera linnaei*		X												
Fabaceae	*Jacksonia aculeata*						X								
Fabaceae	*Jacksonia odontoclada*										X		X		
Fabaceae	*Leptosema chambersii*			X	X						X				
Celastraceae	*Macgregoria racemigera*										X	X			
Apocynaceae	*Marsdenia australis*													X	
Myrtaceae	*Melaleuca lasiandra*						X								
Fabaceae	*Mirbelia viminalis*													X	
Asteraceae	*Olearia ferresii*								X						
Poaceae	*Paraneurachne muelleri*		X	X	X						X	X	X		X

		Groundrush					Kookaburra East					Supernova			
Family	**Scientific name**	**G1**	**G2**	**G3**	**G4**	**G5**	**K1**	**K2**	**K3**	**K4**	**K5**	**S1**	**S2**	**S3**	**S4**
Fabaceae	*Petalostylis cassiodes*	X	X												
Asteraceae	*Pluchea dentex*								X						
Amaranthaceae	*Ptilotus obovatus*	X													
Malvaceae	*Rulingia loxophylla*	X	X	X									X		
Santalaceae	*Santalum lanceolatum*												X		
Phyllanthaceae	*Sauropus trachyspermus*									X					
Goodeniaceae	*Scaevola spinescens*										X				
Fabaceae	*Senna art. spp. artemisioides*					X									
Fabaceae	*Senna costata*						X								
Fabaceae	*Senna pleurocarpa*									X					
Malvaceae	*Sida arenicola*												X		
Malvaceae	*Sida filiformis*						X								
Solanaceae	*Solanum chippendalei*	X													
Solanaceae	*Solanum ellipticum*					X									
Solanaceae	*Solanum petrophilum*											X			
Fabaceae	*Tephrosia sphaerospora*				X										
Poaceae	*Themeda triandra*				X										
Aizoaceae	*Trianthema oxycalyptrum*														X
Aizoaceae	*Trianthema triquetra*											X			
Zygophyllaceae	*Tribulopis angustifolia*				X										
Boraginaceae	*Trichodesma zeylanicum*										X				
Poaceae	*Triodia intermedia*													X	X
Poaceae	*Triodia pungens*		X	X		X	X	X	X	X	X	X		X	X
Poaceae	*Triodia schinzii*		X										X		
Fabaceae	*Vigna lanceolata*								X						

Appendix 4. Datasheet for Site Description : Habitat and vegetation attributes. (Take from Neave *et al*. (2004)).

Site No.:	**Survey number;**	**Quad. size:** 30x30 50x50 other:

Date:	**Observer:**	
Site description & location details:		**Landform pattern:**

Zone:	**GPS AMG:**	**E**	**N**	**Datum:**
Precision:		**GPS elevation:**		

Topographic position:		**Photo ref. no.:**
Land unit:	**Run:** on off plain	**Patch size (ha):** <1 1-5 5-50 50-500 500+
Edge: ecotone ***or*** closest distance:		**Road Type in Vicinity:** 1 2 3 4
Perm. Water: 0 <50m 50-500m 0.5-5km >5km		**Curr. water:** 0 <50m 50-500m 0.5-5km >5km
Climate: 1 = Dry, plant stress 2 = Dry, no plant stress 3 = Recent rain, no vegetation response 4 = Recent rain, noticeable vegetation response		

Disturbance:
0 = no visible impact
1 = disturbance present but negligible impact
2 = low level of disturbance throughout quadrat, *or* moderate level in patches in the quadrat
3 = moderate level of disturbance throughout quadrat, *or* high level in patches in the quadrat
4 = high level of disturbance throughout quadrat, *or* major level in patches in the quadrat
5 = major impact affecting all of quadrat

Fire impact: 0 1 2 3 4 5	**Last fire:** this year last year 2+ years ago long unburnt	
Rabbit damage: 0 1 2 3 4 5	**Introduced herbivores:** 0 1 2 3 4 5	**Camels:** 0 1 2 3 4 5
Weeds: 0 1 2 3 4 5	**Other:** 0 1 2 3 4 5 **describe:**	

Bare soil (%):	%	**Vegetation Litter (%):**	%	**Rock type**
Rock cover (%):	%	**Ground Vegetation (%):**	%	Sandstone Conglomerate Other sedimentary: Metamorphic Granite Quartzite Limestone Basalt Colluvium Other:
Outcrop: %	**Rock / stone:** %	**Bare ground:** %		

Pebbles (<0.6cm):	0 <2 2-10 10-20 20-50 50-70 70-90 >90	
Small stones (0.6-2cm):	0 <2 2-10 10-20 20-50 50-70 70-90 >90	
Stones (2-6cm):	0 <2 2-10 10-20 20-50 50-70 70-90 >90	
Small rocks (6-20cm):	0 <2 2-10 10-20 20-50 50-70 70-90 >90	
Rocks (20-60cm):	0 <2 2-10 10-20 20-50 50-70 70-90 >90	
Big rocks (60cm-2m):	0 <2 2-10 10-20 20-50 50-70 70-90 >90	
Boulders (>2m):	0 <2 2-10 10-20 20-50 50-70 70-90 >90	**Lithology:**
Outcrop / slab:		

Soil texture: sand sandy loam loam loamy clay clay loam clay cracking clay peat rock other: **Soil colour:**		
Soil depth (cm): 0 <10 10-40 >40	**Soil pH - surface**:	**___cm:**
Soil crust, termites, log habitat and vegetation strata structure		
Crust present: no black green clear	**Crust cover (%):** %	**Crust pH:**
Termite mounds (no.):	**Max. ht. (m):**	**Profile:** tower dome underground
Number of fallen logs >15cm diameter in the quadrat:		

Vegetation community: *(Circle one)*	**Percentage foliage cover of tallest plant layer**			
Life form and height of tallest stratum	**Dense (70-100%)**	**Mid-dense (30-70%)**	**Sparse (10-30%)**	**Very sparse (<10%)**
Trees > 30 m	Tall closed-forest	Tall open-forest	Tall woodland	Tall open-woodland
Trees 10-30 m	Closed-forest	Open -forest	Woodland	Open-woodland
Trees 5-10 m	Low closed-forest	Low open-forest	Low woodland	Low open-woodland
Shrubs 2-8 m	Closed -scrub	Open-scrub	Tall shrubland	Tall open-shrubland
Shrubs 0-2 m	Closed -heath	Open-heath	Low shrubland	Low open-shrubland

Three most dominant species:		
Overstorey	**Midstorey**	**Lower storey**
1.	**1.**	**1.**
2.	**2.**	**2.**

Strata	**Dominant species** (record in order of dominance)	**Average ht. (m) of strata**	**Cover (%) of strata** (% cover classes)
Emergent tree layer:			<10 10-30 30-70 >70
Upper shrub layer:			<10 10-30 30-70 >70
Lower shrub layer:			<10 10-30 30-70 >70
Ground layer:			<10 10-30 30-70 >70

Appendix 5. Plant specimen label for collecting or photographing unknown plants for identification by Herbarium or Low Ecological Services P/L . (NSW Government, 2009)

Plant Identification
Submit a separate form, in duplicate, for each specimen.
Send only specimens which have been pressed flat between sheets of newspaper.

Name		
Postal Address		
Phone	Date submitted	Specimen of file no.
Information required: (Identification only will be supplied unless otherwise requested).		
Collection details: Fill in relevant sections		
Collector:		**Date collected:**
Locality: (Distance and direction from nearest town)		
Latitude	Longitude	
Habitat: Crop: (specify)		❑ Pasture ❑ Roadside ❑ Garden
Native vegetation: (specify)		
Occurrence: ❑ Growing naturally ❑ Cultivated		
Habit: ❑ Annual ❑ Perennial ❑ Tree ❑ Shrub ❑ Herb ❑ Vine ❑ Other (specify)		
Height: ..... (m) Trunk diameter @ 1.2 m (trees) ..... (m)		
Abundance: ❑ Rare ❑ Occasional ❑ >10 ❑ > 100 ❑ > 1000		Area covered ..... (ha)
Flower colour:		
Bark colour and texture:		
Substrate (rock type):		
Soil type:		
Remarks:		
Herbarium response – Plant identification:		
Identified by:		Date:

Plant Identification
Submit a separate form, in duplicate, for each specimen.
Send only specimens which have been pressed flat between sheets of newspaper.

Name		
Postal Address		
Phone	Date submitted	Specimen of file no.
Information required: (Identification only will be supplied unless otherwise requested).		
Collection details: Fill in relevant sections		
Collector:		**Date collected:**
Locality: (Distance and direction from nearest town)		
Latitude	Longitude	
Habitat: Crop: (specify)		❑ Pasture ❑ Roadside ❑ Garden
Native vegetation: (specify)		
Occurrence: ❑ Growing naturally ❑ Cultivated		
Habit: ❑ Annual ❑ Perennial ❑ Tree ❑ Shrub ❑ Herb ❑ Vine ❑ Other (specify)		
Height: ..... (m) Trunk diameter @ 1.2 m (trees) ..... (m)		
Abundance: ❑ Rare ❑ Occasional ❑ >10 ❑ > 100 ❑ > 1000		Area covered ..... (ha)
Flower colour:		
Bark colour and texture:		
Substrate (rock type):		
Soil type:		
Remarks:		
Herbarium response – Plant identification:		
Identified by:		Date: